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COMMERCIAL SPACE OPPORTUNITIES

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON

COMMERCIAL SPACE OPPORTUNITIES

OCTOBER 5, 1987

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COMMERCIAL SPACE OPPORTUNITIES

MONDAY, OCTOBER 5, 1987

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE,
Houston, TX.

The subcommittee met, pursuant to notice, at 9:30 a.m., in the Olin E. Teague Auditorium, Visitors Center, Building 2, Lyndon B. Johnson Space Center, Hon. Lloyd Bentsen, presiding.

Staff members assigned to this hearing: Marty Kress and John Graykowski, professional staff members and Pete Perkins, minority professional staff member.

OPENING STATEMENT BY SENATOR BENTSEN

Senator **BENTSEN**. This hearing of the Subcommittee on Space for the Commerce Committee will get underway.

I am delighted that my distinguished colleague, Senator Larry Pressler, of South Dakota, ranking member of the subcommittee, has joined us in attendance.

I urged the Science, Technology and Space Subcommittee to come here to find some answers to some very troubling questions.

What has happened to the high hopes that we had for the commercialization of space?

Why has it not lived up to some of the expectations that we had for it?

What do we have to do to get us lift-off in orbit?

I plan to use the information and the insights that we develop here in these hearings to develop a new Commerce in Space Act so that the United States can be a leader in this field through creative cooperation between government and industry.

Thirty years ago this morning, Americans awakened to find that the space race was underway and we were already behind. You can think of moments in history and you will remember exactly where you were. I happened to have been in Caracas, Venezuela, that morning as we heard about this startling news.

It was on October 5, 1957, that the Houston papers reported the launching of the first Soviet Sputnik. That was a shocking event which really destroyed our complacency and spurred us to seek and to attain leadership in space.

Now we face an even broader challenge. The Russians have put their space station into orbit, and ours is a decade away. The United States are still stalled in disputes over its value and its cost.

At this very time, we are talking in the U.S. Senate about reducing appropriations for space, and for the space station. At the same time, find several nations who are bidding to put payloads into orbit, and our space shuttle is grounded. Until we are sure that we have solved the problems which led us to the *Challenger* tragedy. I think space represents an enormous opportunity for American ingenuity, if we can find the will and of we can find the way.

We already have about 100 companies who are investing their own funds in commercially oriented space research and technology development, but most of those are still in the planning stages, with a total investment not over $100 million.

That figure is not going to climb substantially until investors have a greater confidence in the future of commerce in space. We are not going to be able to continue to get the amount of money that is needed for the research and the work that has to be done in NASA unless we can see some spin-offs in commercialization.

It is not enough to satisfy the curiosity of scientists as to what is out there, we have to find ways where it improves the standard of living of our own people, and that means the commercialization of it.

That is the only way you are going to continue to get the support that is needed in the U.S. Congress to push our exploration of space.

We are going to hear from the distinguished Director of the Johnson Space Center, Aaron Cohen; from the Deputy General Counsel of NASA, Ed Frankle, and from some leaders in Houston in the commercial space industry.

We are also going to hear from Walt Cunningham, of the Chamber of Commerce, and from David Norton, of the Houston Area Research Council.

Each one of these witnesses has been asked to identify any legal or any regulatory barriers to space commercialization.

As a Senator for Texas, I certainly want to do everything I can to encourage these new growth opportunities which we have already launched, and I know that my colleagues on the Senate Commerce Committee share the view of pushing ahead.

Every 90 minutes, as Dr. Cohen was telling me just a few minutes ago, we have a Russian space station that passes over us, orbiting in space, and we do not have anything at the moment comparable.

Time is of the essence. The job has to be done. These hearings could not be more timely in my view.

I would like to defer now to my colleague, Senator Pressler, for any comments he might have.

OPENING STATEMENT BY SENATOR PRESSLER

Senator **Pressler**. Thank you very much, Mr. Chairman. I do have a brief opening statement.

First, let me say that this is my first opportunity to visit the Johnson Space Center since I assumed the position of Ranking Republican Member on the Subcommittee on Science, Technology and Space, and I welcome the opportunity to become better acquainted with the people and activities of the Johnson Space Center. In fact, I have previously visited Kennedy Space Center in Florida and hope to visit Marshall Space Flight Center in Alabama. In addition, we are taking a tour this afternoon of the Johnson Space Center, so I am killing two birds with one stone today.

As this hearing begins, it is worth noting the key role that Johnson Space Center has played in the development of our nation's civil space program. For years the world has been reminded of its critical role, as television broadcasts of our manned space launches have brought into our homes the drama and excitement of Mission Control Center right here at Johnson Space Center. Senator Bentsen, you are indeed fortunate to have Johnson Space Center as a constituent. Furthermore, I commend you for calling this important hearing, particularly at a location that evokes such vivid memories of our civil space program.

For those of you who have watched and even participated in this new era of space commercialization, you have learned that space commercialization is on a real roller coaster ride. Four years ago, when this era of space commercialization took off, the enthusiasm for its potential was outracing anyone's ability to develop realistic and effective policies. An example of this enthusiasm was a projection of one company that commercial space ventures would yield $60 billion in gross annual revenues by the year 2000. Now, four years later, our expectations are a bit more modest. The ramifications of the *Challenger* accident and the unproductive experiences of some commercial space entrepreneurs have injected more reality into the picture. We have learned that the road to successful space commercialization is neither straight nor smooth. Yet, for those who are supporters of space commercialization, and I count myself as one, we must get down to the business of understanding the obstacles and developing the right solutions.

First and foremost, the administration, NASA and Congress must decide on the priority that space commercialization should have within the context of our whole space program. For years we have talked about our desire for leadership in space and how space commercialization can support that leadership. Yet, we have often failed to provide the support necessary to make space commercialization a successful reality. For instance, in the promising arena of materials processing in space, we are in great jeopardy of handing over to the Europeans and the Japanese a potentially lucrative market. This threat has been documented in several internal NASA reports, the most recent of which is the Report of Microgravity Materials, Science Assessment Task Force, headed by Astronaut Bonnie Dunbar. This report highlights, among other things, that NASA's microgravity sciences programs have received inadequate budgetary support and that the Japanese and Europeans are taking greater advantage in the United States of the shuttle's space lab capabilities, which are critical to materials processing in space activities. If we are truly serious about maintaining our nation's competitive edge in science and technology, we cannot afford to ignore the commercial potential of materials processing in space.

Similarly, in the conduct of commercial space launches we are experiencing strong competition from the European Space Agency, and now China and the Soviet Union are threatening to break into the global market for launch services.

While there may be little that the government can do to influence marketing by our competitors, we must ensure that our domestic launch companies are not needlessly disadvantaged by onerous regulations and policies.

It goes without saying that the current culture of commercial space services and activities may be difficult at times to incorporate into the historical mode of governmental space operations. If we are indeed serious, however, about space commercialization, we must be prepared to expand our view of space operations. We must be willing to consider new ideas, new modes of financing, and new technological solutions. We cannot afford to reject outright new ways of doing business in space simply because they may be different than the way we have been doing business for the last 30 years.

It is no secret that our national space program is at its most critical juncture. The *Challenger* accident and subsequent events have opened our eyes to the reality that our civil space program no longer enjoys the unchallenged superiority that we have complacently assumed for so many years. This is documented in the recent report prepared for NASA Administrator Dr. Jim Fletcher, by a task force headed up by Sally Ride. The task force has concluded "the United States has clearly lost leadership in the area of Mars exploration and low Earth orbit space operation and is in danger of being surpassed in many other areas during the next several years." Whether this trend continues, depends on the will of the American people and the government. The decisions that we make over the next couple of years will dictate the character of our future space program. "Will we affirm our leadership and chart a new course that will open up our solar system and beyond, or will we be content with a space program that is no different from that of a half dozen other nations?"

Make no mistake about it, space leadership cannot be "bought on the cheap". If we want to demonstrate rather than talk about space leadership, it must be established as a top national priority. As we consider these and other issues today, the subcommittee is fortunate, as Senator Bentsen has pointed out, to have with us Mr. Aaron Cohen, the Director of the Johnson Space Center, who has graciously chosen to take time out from his busy schedule to testify. Furthermore, this subcommittee is fortunate to have today the other witnesses who represent companies that are the true pioneers of space commercialization. Your representative companies are breaking new ground and should be commended for your bold and adventuresome outlook on our country's future in space. With these thoughts in mind, I turn the hearing back to Senator Bentsen.

I would ask unanimous consent to place in the record by reference an article I read last night in the Houston paper by Senator Lloyd Bentsen, entitled, "Open For Business In Space," which I thought was very insightful.

Senator **BENTSEN**. Senator, you will not find any objection here to that. That is just fine. I am delighted to do that.

Senator Hollings, the Chairman of the full Committee could not make it here today. But he has authorized me to place his statement in the record, which I will now do.

[The statement follows:]

OPENING STATEMENT BY THE CHAIRMAN

Mr. Chairman, I am most pleased you have requested this field hearing and that we were able to conduct this session at the Johnson Space Center. It's nice to be in the heartland of the space program.

Mr. Chairman, for a long time now we have heard the administration toot the horn of space commercialization but with few visible results. Today, you have brought us to JSC so that we can determine for ourselves the current status and meaning of the commercial space program.

I must admit that I come to the hearing with certain biases towards the administration's space commercialization program—biases which stem from two very negative experiences with the Administration's commercial space program while serving as Chairman of an Appropriations Subcommittee.

First, in the case of the Landsat program, I have seen the Administration solicit bids for the privatization of an existing federal system and then renege on the commitment to provide transitional support to the winning contractor when the bill came due. The fact that all parties agreed to the need for such support and provided for it in the Land Remote-Sensing Commercialization Act of 1985 did not influence the administration or its view of a contractual commitment. For over two years, the Congress continued its fight with the Administration over the Landsat program, and to date the only winner has been SPOT IMAGE, the French remote sensing system which is having great success marketing its data in the United States.

Second, let's take the case of commercial expendable launch vehicle services. The NOAA recently put out a request for proposals for "commercial launch services" for the launch of the GOES weather satellites. This action was in compliance with the White House's space policy but in conflict with existing law since NOAA lacked the legal authority to enter into contracts for commercial launch services. (For that matter, so does the Department of Defense and so does NASA. I corrected that situation for NOAA in the supplemental appropriations bill, and I have language in the Senate-passed NASA authorization bill that will correct that problem for NASA. No action has been taken yet for DOD.

The reason I raise these issues is to make the point that it is one thing to formulate policy and it is another thing to implement policy.

Despite all the rhetoric and the White House policy proclamations, I am concerned that we don't have clearly defined rules of the road or policies regarding the Nation's support of commercial space activities. We in the Congress support commercial space activities. But we have apparently failed to provide the right incentives to stimulate this new industry. Commercial space activities are being threatened by foreign competition. We have to do everything possible to make our commercial space firms competitive in order to capture a significant share of the market.

The United States has invested well over $200 billion in 1984 dollars in the civil space program, and the time has come for the United States to get an additional return on its investment. However, for that to be possible, the Federal Government must create a stable space policy and regulatory framework and eliminate government-induced barriers to the commercialization of space.

Today, we are here in Houston to grade the Federal Government's performance in eliminating those barriers and in articulating a space policy. We're here to determine if our actions have kept up with our words and to make sure that United States, NASA, and the Johnson Space Center are committed to commercial space. We're here to determine if we're a reliable partner and to better understand our obligations.

I look forward to the inputs of the distinguished witnesses who will appear before the subcommittee today, and I hope that I can walk out of this hearing convinced that the commercialization of space is a reality and not a dream, and that my experiences to date are the exceptions and not the rule.

Finally, let me say I would be remiss if I did not congratulate the University of Houston for its recent breakthrough in superconductivity. This discovery points to endless commercial opportunities and manifests the benefits of a clearly defined partnership with the federal government. I know the Chairman is proud, as is NASA, since the University of Houston is one of the NASA Centers for the Commercial Development of Space.

Senator **BENTSEN**. Gentlemen, we are really pleased that you have agreed to testify at this hearing on space commercialization, and I am optimistic that when we finish these panels this morning we will have a better understanding of some of the regulatory problems, and some of the concerns that possibly we can help with and try to correct.

I am going to ask, because we want a dialogue as much as a statement, that you limit your statements, to 7 minutes and this is for all witnesses. We will place the statement in its entirety in the record, but I would like to have a chance for some communication between us.

We also want to thank you for the hospitality of the facilities and the generosity of your time, and I again want to express the regret of Senator Hollings, who is Chairman of the full committee, who wanted to be very much in attendance.

I assured him what Houston weather was like, and we obviously have it here this morning, but he is deeply interested in this program, as I am, and better understanding of what is happening with the program here.

I would like to start with you, Dr. Cohen, if you would proceed, and then we will hear Mr. Frankle next.

STATEMENT OF AARON COHEN, DIRECTOR, LYNDON B. JOHNSON SPACE CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, ACCOMPANIED BY EDWARD A. FRANKLE, DEPUTY GENERAL COUNSEL, OFFICE OF THE GENERAL COUNSEL

Mr. **Cohen**. Senator Bentsen and Senator Pressler, welcome. It is with great pleasure that I do welcome you to the Lyndon B. Johnson Space Center in Houston, Texas.

A hearing on commercialization of space in such a setting seems quite appropriate since a number of significant initiatives have originated here. This community is interested in the diversification of its economy. Space commercialization initiatives are attractive because talent is available from the 25 years of space activity at the Lyndon B. Johnson Space Center.

There are similar initiatives at many of our sister centers for essentially the same reasons.

Let me summarize for you the Johnson Space Center's role in NASA's space commercialization endeavors.

The Johnson Space Center is primarily a development and operations organization for NASA's manned space flight program. We do research in areas that are complementary to our development and operations role.

Therefore, our primary participation in NASA's commercial program activity is in the implementation of flight accommodations for commercial payloads.

The Johnson Space Center is responsible for the engineering analysis of each payload assigned to a specific flight. These analyses examine the characteristics of each payload to ensure that it meets safety standards, is compatible with the Orbiter payload accommodations, and is compatible with the other payloads constituting the complete cargo for the flight.

An elaboration on that process is included in my full report.

This procedure is critical to both the success and safety of the space transportation system operations.

The work we do is intended to lend new space endeavors the benefit of our hard-won experience. We allow them to innovate as boldly as they wish, so long as it does not jeopardize government assets or accompanying projects or people in a flight.

Space-based ventures initiated by those without prior space flight experience face some uphill battles. We have a number of programs designed to minimize the risk and decrease capital costs, and I will go through some of those for you.

To facilitate access to information necessary to support business decisions as to space-based ventures, the Johnson Space Center and the University of Houston-Clear Lake have developed a space-based information center, a data base where businesses considering entering into space enterprises can access historical data, directories, market and economic statistics, and other data needed to support business decisions.

This system also acts as a pointer to other data bases in which various classes of technical data are stored.

A collateral activity is what we call our customer service center, which provides specific space transportation system data to potential users. The center has processed over 3,330 inquiries as of August 1987.

The center maintains a mailing list of all current and potential users and routinely apprises them of modifications in capability and requirements.

Another means for providing potential commercial customers with information is through the participation in the particular informal research discipline colloquiums sponsored by the Astronaut Science Support Group.

The colloquia are not restricted to the discussion of one payload but rather provide a forum for discussion of a specific subject; for example, an area of research with the crew personnel that will have to operate the proposed devices.

The colloquia allow the customers to establish early scientific and technical interfaces and to discuss in detail the payload operational considerations and constraints experienced by similar ventures.

These discussions often influence the payload flight hardware design, which helps prevent the customer from spending his project funds on ideas and solutions to problems that have previously been solved.

Companies such as 3M and Boeing have participated in these colloquiums where proprietary interests are protected by common experience shared. We believe both NASA and the companies benefit from this.

The Commercial R&D Enhancements Program is aimed at providing accommodations that are required by several commercial payloads but which have not been required for predecessor NASA payloads.

The Johnson Space Center has developed two such systems to facilitate the accommodation of commercial payloads. Other centers, particularly the Marshall Space Flight Center and Goddard, have developed other systems.

The Johnson Space Center has developed a middeck accommodation system that is compatible with either the Orbiter middeck or Spacelab module rack assignment, which permits a user to design to either flight accommodation.

Such an arrangement facilitates customer planning because he can design his payload to maximize flight opportunity without regard to other attributes of the flight.

For the customer, there is a significant benefit in being compatible with a standard accommodation because it maximizes his potential opportunities for flight.

The Centers for Commercial Development of Space are a consortia of industry, academia and government for research leading to new commercial uses of space.

The recent superconductivity research breakthrough was conducted by two of the scientists involved with these centers. There are now sixteen of these centers, and the Johnson Space Center is associated with five of them.

They are: The Center for Space Automation and Robotics at the University of Wisconsin; the Center for Cell Research, Pennsylvania State University; the Center for Bioserve Space Technologies, University of Colorado, Boulder; the Center for Space Power, Texas A&M, and the Center for Automation and Man-Controlled Robotics and Sensing System, the Environment Research Institute of Michigan.

As the titles of the centers indicate, their interests complement our life sciences research programs and our research and technology activities in developing new and more efficient space systems and operations.

It is important to note the purpose of these centers. Many industries perceive incipient opportunities in space ventures but the research and technology base is still too shallow to assure them space-based research or production is efficient and effective in the business in which they may wish to compete.

These centers offer a mechanism for them to explore those opportunities at reasonable risk. The centers benefit industry by revealing new opportunities; they benefit universities by providing a focus for selected areas of research; they benefit NASA and the nation by stimulating and focusing support to those scientific and technological developments where coordinated research is likely to be most effective in the interest of all parties.

I would like to close by saying that success for NASA can be defined in relatively simple terms. If we execute our responsibility effectively, two things will occur; horizons of this nation and the world will be expanded to encompass possibilities far beyond today's capabilities; and the second is space-related industry will grow without bounds and NASA's role will be a small part of the whole. It happened in aeronautics and I believe it will also happen in space.

Thank you very much for this opportunity.

[The statement follows:]

Statement of

Aaron Cohen
Director
Lyndon B. Johnson Space Center
National Aeronautics and Space Administration

Mr. Chairman and Distinguished Members of the Subcommittee:

It is with great pleasure that I welcome you to the Lyndon B. Johnson Space Center in Houston, Texas. A hearing on the commercialization of space in such a setting seems quite appropriate since a number of significant initiatives have originated here. This community is interested in the diversification of its economy. Space commercialization initiatives are attractive because of the availability of knowledgeable technical talent resulting from the 25 years of space activity focused at the Lyndon B. Johnson Space Center (JSC). There are similar initiatives at many of our sister centers for essentially the same reasons.

Let me summarize for you JSC's role in NASA's space commercialization endeavors.

JSC is primarily a development and operations organization for NASA's manned space flight program. We do research in only the few areas that are complementary to our development and operations role. Therefore, our primary participation in NASA's commercial programs activity is the implementation of flight accommodations for commercial payloads.

JSC is responsible for the engineering analysis of particular payloads assigned to specific flights. These analyses examine the characteristics of each payload to insure that it meets safety standards, is compatible with the Orbiter payload accommodations, and is compatible with the other payloads constituting the complete cargo for the flight. An elaboration on that process is included in Appendix A. This procedure is critical to both the success and safety of the Space Transportation System (STS) operations.

To escape the Earth's gravity and enjoy the benefit of space requires the expenditure of large amounts of energy in a short period of time. To do so successfully requires care and attention to detail. The work we do is intended to lend new space endeavors the benefit of our hard won experience. We allow them to innovate as boldly as they wish so long as it does not jeopardize Government assets or accompanying projects or people in a flight.

I would add that we are striving to streamline the process, prune it of nonessential activities or documents. We want to avoid unreasonable rigor in defining requirements and respond positively to the critiques of experienced users -- many of whom have made useful and insightful suggestions. It has been a learning process for all participants. The process today is significantly more efficient than it has been in the past.

Space-based ventures initiated by those without prior spaceflight experience face an uphill battle. We have a number of programs designed to minimize risk and decrease capital costs.

OUTREACH

To facilitate access to information necessary to support business decisions to enter into space-based ventures, JSC and the University of Houston-Clear Lake have developed a Space Business Information Center. This contains a data base where businesses considering entering into space enterprises can access historical data, directories, market and economic statistics, and other data needed to support business decisions. This system also acts as a pointer to other data bases in which various classes of technical data are stored.

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COMMERCIAL R&D ENHANCEMENTS

The Commercial R&D Enhancements Program is aimed at providing accommodations that are required by several commercial payloads but which have not been required for predecessor NASA payloads. JSC has developed two such systems to facilitate the accommodations of commercial payloads, other Centers (particularly the Marshall Space Flight Center and Goddard Space Flight Center) have developed other systems.

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CENTERS FOR THE COMMERCIAL DEVELOPMENT OF SPACE (CCDS)

The CCDS's are consortia of industry, academia, and Government for research leading to new commercial uses of space. The recent superconductivity research breakthrough was conducted by two of the scientists involved with these Centers. There are now 16 CCDS's and JSC is associated with 5 of them:

- Center for Space Automation and Robotics - University of Wisconsin
- Center for Secretion Research - Pennsylvania State University
- Center for Bioserve Space Technologies - University of Colorado - Boulder
- The Center for Space Power - Texas A&M
- Center for Autonomous and Man-Controlled Robotic and Sensing System - Environment Research Institute of Michigan

As the titles of the Centers indicate, their interests complement either our life sciences research programs or our research and technology activities in developing new more efficient space systems and operations.

It is important to note the purpose of these Centers. Many industries perceive incipient opportunities in space ventures but the research and technology base is still too shallow to assure them that space-based research or production is efficient and effective in the domains in which they wish to compete. These Centers offer a mechanism for them to explore those domains at reasonable risk. They benefit industry by revealing new opportunities, they benefit universities by providing a focus for selected areas of research, and they benefit the Nation and NASA by stimulating and focusing support to those scientific and technological developments where coordinated research is likely to be most effective in the interest of all parties.

SMALL BUSINESS INNOVATION RESEARCH (SBIR)

The SBIR Program was established by the Small Business Innovation Act of 1982 (Public Law 97-219 [S. 881]). JSC has participated in the NASA program since its inception.

There are now some 44 projects in Texas, from all SBIR initiatives (NASA, DOE, DOD, etc.). The program has clearly been successful from our perspective. It provides an effective entrance for new ventures that benefit both federal and commercial uses of new technology, which is the stated purpose of the program. JSC currently has 23 Phase II or product development projects under way of which 4 are in Texas.

I am happy to report that this has been a useful adjunct to our basic research and development program. Frankly, in prospect we did not welcome it, in retrospect we do. It has been the source of some very good concepts and proposals, some of which we may use in the Space Station design. Others have shown promise for significant commercial markets as well as support of our research programs.

TECHNOLOGY UTILIZATION

The use of NASA "spin-off" technology in other fields is the oldest of our commercialization endeavors. It has a long history of success.

For example, we have done projects with the Veterans Administration to transfer the technology of the lunar rover vehicle to control of automotive vehicles for paraplegic veterans. Our noninvasive biomedical instrumentations techniques are highly prized by many medical institutes for treatment of cancer and other intensive care patients. Body cooling devices based on space suit technology are used in chemotherapy to minimize adverse side effects such as a loss of hair. A laser wire stripper developed for the Shuttle program is now in wide use in the electronics industry. In each such case, there is an explicit benefit.

Gentlemen, I have tried to illustrate how important we believe the commercialization of space is and how we try to support agency programs to facilitate its implementation.

I would like to close by saying that success for NASA can be defined in relatively simple terms. If we execute our responsibility effectively, two things will occur:

- Horizons of this Nation and the world will be expanded to encompass possibilities far beyond today's capabilities.
- Space-related industry will burgeon and NASA's role will be a small part of the whole. It happened in aeronautics and I believe it will happen in space.

Thank you for this opportunity to speak with you.

APPENDIX A

INTEGRATION PROCESS

DEVELOPMENT OF FORMAL AGREEMENTS

The first step in the integration process is for the customer or his representatives to submit a Request for Flight Assignment (RFA) to NASA Headquarters, Washington, DC. NASA Headquarters provides the terms and conditions which define the roles of the customer and NASA. When a Launch Services Agreement (LSA), Joint Endeavor Agreement (JEA), or Space System Development Agreement (SSDA) is concluded, Headquarters Office of Space Flight reviews, endorses, and forwards an RFA to JSC and other field installations, as appropriate. If the proposed concept lacks the definition maturity to warrant such action, a Memorandum of Understanding (MOU) may alternatively be negotiated to authorize technical discussions to bring the proposal to the necessary maturity. Figure 1 depicts the integration process.

When NASA Headquarters transmits the RFA to JSC, the technical integration process is formally authorized to begin. At JSC, a Payload Integration Manager (PIM) is assigned to the payload customer, and remains the customer's primary point of contact throughout the entire process. Since NASA is a large complex organization and it is unreasonable to require the customer to learn all the details of its structure and ways of doing business, we have established the PIM as his guide and advocate within the system. The PIM is responsible for ensuring that the customer's requirements have been accurately defined and documented, are compatible with Orbiter payload accommodations, and are properly implemented. The PIM also coordinates any engineering or other technical support required at JSC. Additionally, a Launch Site Support Manager (LSSM) is assigned and is the customer's point of contact at the launch and landing site.

The PIM initiates a meeting with the customer at JSC. At this meeting, the PIM reviews the integration process and familiarizes the customer with the JSC and Kennedy Space Center (where the launch takes place) operations. The customer provides a detailed description of the planned payload, and formal development of the customer's requirements begins.

The key documents which will be developed and employed in the course of the payload integration process are the Launch Services Agreement (SSDA, JEA, MOU, etc.), the individual Payload Integration Plan (PIP) with appropriate PIP Annexes, and the payload's Interface Control Document (ICD) (see Figure 2).

PAYLOAD INTEGRATION PLAN

Following the assignment of the payload to JSC, the payload integration process begins with the development of a PIP. The purpose of the PIP is to:

a. Define responsibilities of the customer and the NSTS.

b. Define the technical baseline for implementation.

c. Establish guidelines and constraints for integration and planning.

d. Define integration tasks to be accomplished.

e. Establish interface verification requirements.

f. Establish operational service requirements.

g. Establish controlling schedules for all major integration activities.

h. Identify NSTS flight and ground safety requirements.

i. Establish the basis for NSTS definition and pricing of optional services.

STANDARD INTEGRATION PLANS (SIP)

To facilitate the process, we have established SIP's to serve as guides or "blank books" for the development of PIP's. An SIP has been developed for each generic type of payload (e.g., deployable, attached, etc.). The SIP contains the technical requirements, management interfaces, services, and schedules that normally apply to that type of payload.

PIP ANNEXES

PIP Annexes are designed to aid customers in outlining the detailed technical requirements and data required to configure both flight and ground systems to implement integration functions as outlined in the PIP. Generic annexes have been developed to help the customer understand what data is required to generate each appropriate annex. All requirements outlined in the annexes must be within the general scope of the PIP and are considered binding on both the NSTS and the payload developer. Not all annexes are required for every payload. The annexes are:

Annex 1: Payload Data Package - Consists of payload mass properties, configuration drawings including payload electrical power and command interface drawings, radio frequency radiation data, and payload physical function data.

Annex 2: Flight Planning - Includes data required to define electrical power and cooling profile, deployment/retrieval/proximity operations requirements, crew activity requirements, attitude and pointing, geographical constraints data, and pointing/timing data for deployment of upper stages.

Annex 3: Data Requirements for Flight Operations - Identifies payload operations support plans; defines flight operations decisions, payload launch commit criteria, joint operations interface procedures, payload operating procedures and malfunction procedures.

Annex 4: Orbiter Command and Data - Identifies individual commands required to operate the payload, measurements of the payload's status and health, and measurements for accomplishing payload objectives. Provides the necessary information for processing and interpreting data.

Annex 5: Data Requirements for the Payload Operations Control Center (POCC) - Defines and details the customer's requirements levied on the STS for POCC, remote POCC, and communications resources.

Annex 6: Crew Compartment - Describes the payload-supplied equipment stowed or installed in the crew compartment and defines requirements affecting stowage, installation, handling, or flight crew use and proposed stowage/installation of payload materials. Includes display and control and standard switch panel nomenclature requirements.

Annex 7: Training - Identifies training of STS personnel provided by the customer, and POCC team training requirements; determines integrated simulation requirements; establishes training sequence flow including customer participation in simulation and training; and provides payload training schedules.

Annex 8: Launch Site Support Plan - Defines payload processing flow at the launch site, defines customer's launch and landing site nominal and contingency support (e.g., scrub/turnaround, intact abort) requirements, and specifies launch site facilities and resources that fulfill customer requirements and provide for his participation as appropriate.

Annex 9: Payload Interface Verification Summary - Identifies project-level verification agreements, payload-to-STS ICD interfaces to be verified, the method of verification, and the location of verification.

Annex 10: Intravehicular Activity (IVA) - Defines specific inflight maintenance and in-cabin activities requiring hardware-to-crew interfaces in the cabin or a customer payload module.

Annex 11: Extravehicular Activity (EVA) - Defines specific design configuration for each hardware-to-hardware and hardware-to-crew interface associated with the EVA support of a particular payload, including planned, unscheduled, and contingency EVA's.

INTERFACE CONTROL DOCUMENT (ICD) AND INTERFACE DEFINITION DOCUMENT (IDD)

ICD defines the detailed design interface specifications for each individual payload. IDD has been developed for each type of payload (standard, small, and middeck) to facilitate the preparation of an ICD; a "dedicated" payload, for example, will employ ICD 2-19001, current issue.

When agreed to and signed by both the payload customer and NASA, the PIP (with its appropriate annexes) and the ICD become the technical details to effect the contract. The PIP also becomes part of the formal legal contract by direct reference in the NASA Headquarters agreement.

The early part of the integration activities (PIP and ICD, specifically) are scheduled to support the design and development schedule of the payload sponsor and of the payload. It is our general recommendation that the PIP be a part of the payload design requirements documentation; and, therefore, it should be developed as early as practical. The unique ICD, if applicable, should be developed in the preliminary design process. The PIP annexes will usually be developed in concert with the customer as his design matures.

Since safety is essential to success, the Phase 0 safety review normally should be conducted very early to ensure that the basic requirements and process are well understood. A Phase I safety review generally refines preliminary design data and should be completed prior to initiation of final design activities. The Phase II safety review generally requires design maturity associated with a critical or final design review. The Phase III review must precede delivery of flight hardware to on-line KSC or VLS facilities.

IMPLEMENTATION OF THE AGREEMENTS

The integration of a payload into a Shuttle flight begins with the preliminary flight assignment process and continues throughout the requirements development phase with each customer. After submittal of the preliminary annex data and completion of the ICD, a series of cargo compatibility assessments is performed. The results of these assessments are presented to the customer and to STS management at the Cargo Integration Review when each payloads attributes are considered in concert with all other payloads planned for a specific flight.

FLIGHT IMPLEMENTATION PROCESS

After the formal agreements have been signed and a preliminary flight assignment released, NASA conducts preliminary cargo engineering analyses, ground operations planning, and mission planning to assure that the cargo elements are compatible with each other and with STS capabilities. To conduct these analyses, NASA requires certain design details on each payload. These details are contained in the PIP and annexes. The cargo engineering analysis and preliminary flight analysis must be completed early enough in the integration process to allow the NSTS completion of the flight products and hardware details required for the flight and to allow the payload provider time to execute his necessary analyses and tests. The results of these analyses are presented in the cargo integration review (CIR). Each customer manifested on the flight is encouraged to participate in this review to ensure that all requirements have been satisfied. With the conclusion of the CIR, final preparation for the mission begins.

FLIGHT OPERATION PREPARATION

When final flight design and flight operations planning products, and any modifications (including software) required by the Mission Control Center (MCC), POCC, and crew training facilities are completed, these products are formally reviewed by the Flight Operations Review board. This review is held to support the final phase of flight crew and flight operations personnel training. The customer participates in periodic payload reviews (by telecon and/or meeting) and, as appropriate, in training and simulation during preparation for flight.

LAUNCH AND LANDING SITE

Payloads undergo final checkout, interface verification, and launch preparation at the launch site. Standard facilities and services are allocated on the basis of customer requirements.

At KSC, the arriving payload goes through a payload processing facility.

Generally, this activity begins with a receiving inspection and includes any required component or subsystem assembly, such as mating to an upper stage or carrier, and experiment integration (Level IV); i.e., integration of his devices to standard NASA-furnished accommodations, etc. After the payload is checked and serviced, it is moved to the payload integration facility for integration with any other payloads scheduled for the same flight.

The integrated payloads undergo interface and system verification testing and are then installed into the Orbiter, either horizontally in the Orbiter processing facility at KSC, the Orbiter maintenance and checkout facility at VAFB, or vertically at the launch pad. After installation in the Orbiter, payload-to-Orbiter interfaces are verified and the payload is closed out for launch. After Orbiter landing, the payload and/or payload ASE are removed from the Orbiter and prepared for shipment to the customer's facility.

PREFLIGHT VERIFICATION

The customer is responsible for verifying the compatibility of payload physical and functional interfaces prior to the payload entering the launch site integration activities. The NSTS is responsible for verifying the compatibility of the integrated cargo. Verification requirements are defined in Annex 9 to the PIP.

PAYLOAD READINESS REVIEW

The Payload Readiness Review is conducted at the launch site prior to payload installation in the Orbiter. The review will assess the readiness of the Orbiter and the payload for the payload on-line integration activities.

FLIGHT READINESS REVIEW

The Flight Readiness Review is conducted during the month before launch to verify that all STS/cargo integration activities have been completed and to certify that all flight elements are ready to perform the mission.

CUSTOMER PARTICIPATION DURING MISSION

During ground operations planning, preflight verification, launch, and post-landing operations, the customer will generally have technical and management representatives at KSC.

During the flight, at least one customer management representative is generally at the JSC Mission Control Center (MCC). This representative will be located in the Customer Support Room. In addition to the customer support at JSC, data can be routed to POCC's at various locations. POCC's can be used to command and control payload operations as well as to receive payload data.

Before a mission, the customer participates in control team training, which consists of briefings and simulations. Simulations usually begin 2 months before launch. These simulations include a fully staffed MCC, the Shuttle Mission Simulator and crew, and remote customer locations. During these simulations, customers are normally involved in several training sessions to rehearse various mission events. It has been our experience that this has unanticipated benefits to the customer in the management of his payload in flight.

Figure 1 - Payload Integration Process

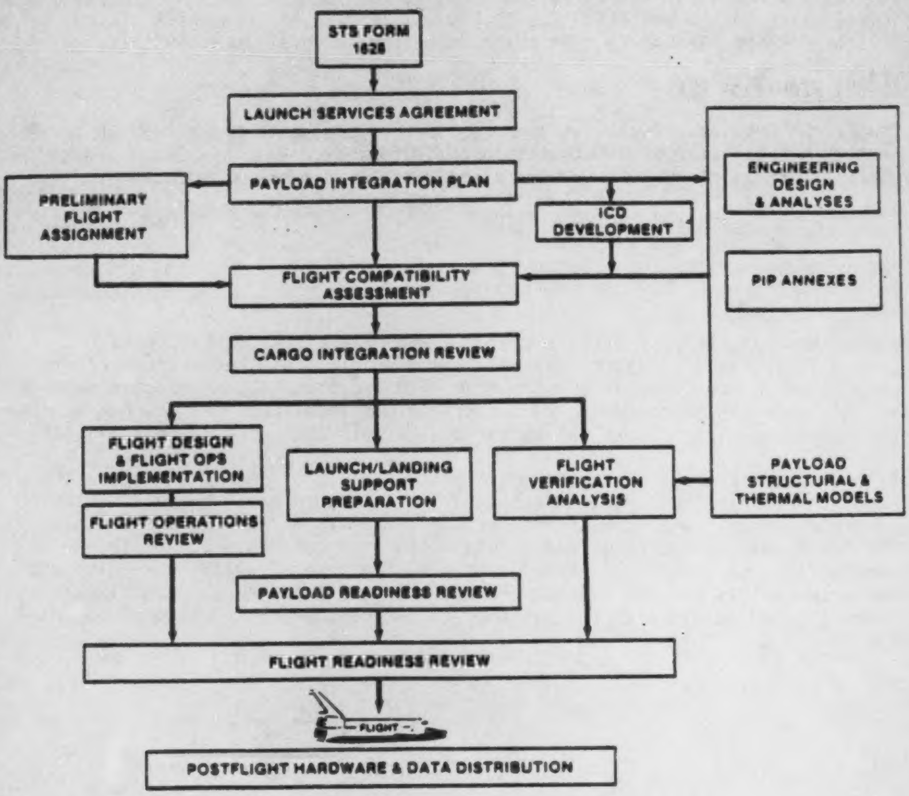
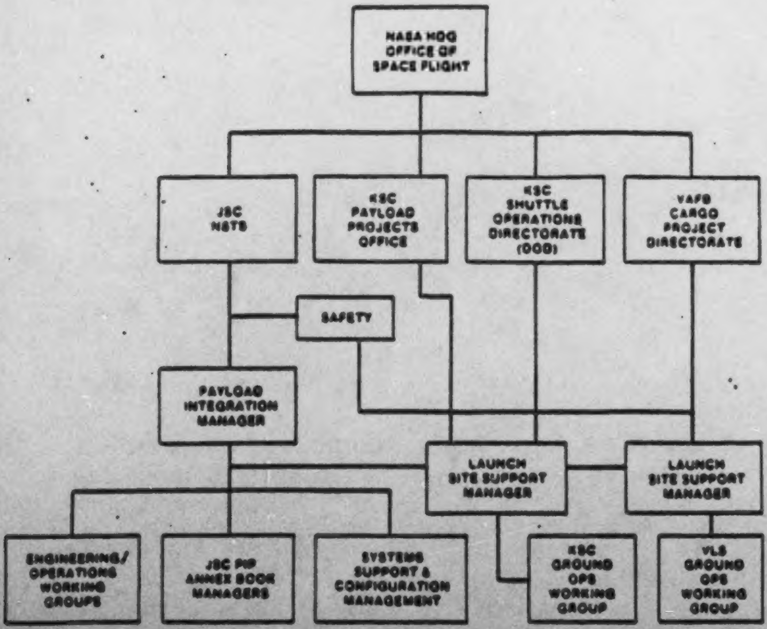

STS FORM 1628
LAUNCH SERVICES AGREEMENT
PAYLOAD INTEGRATION PLAN
PRELIMINARY FLIGHT ASSIGNMENT
ICD DEVELOPMENT
ENGINEERING DESIGN & ANALYSES
PIP ANNEXES
FLIGHT COMPATIBILITY ASSESSMENT
CARGO INTEGRATION REVIEW
FLIGHT DESIGN & FLIGHT OPS IMPLEMENTATION
FLIGHT OPERATIONS REVIEW
LAUNCH/LANDING SUPPORT PREPARATION
FLIGHT VERIFICATION ANALYSIS
PAYLOAD STRUCTURAL & THERMAL MODELS
PAYLOAD READINESS REVIEW
FLIGHT READINESS REVIEW
FLIGHT
POSTFLIGHT HARDWARE & DATA DISTRIBUTION

Figure 2 - Payload Integration Management Organization


NASA HQS OFFICE OF SPACE FLIGHT
JSC NSTS
KSC PAYLOAD PROJECTS OFFICE
KSC SHUTTLE OPERATIONS DIRECTORATE (DOD)
VAFB CARGO PROJECT DIRECTORATE
SAFETY
PAYLOAD INTEGRATION MANAGER
LAUNCH SITE SUPPORT MANAGER
LAUNCH SITE SUPPORT MANAGER
ENGINEERING/ OPERATIONS WORKING GROUPS
JSC PIP ANNEX BOOK MANAGERS
SYSTEMS SUPPORT & CONFIGURATION MANAGEMENT
KSC GROUND OPS WORKING GROUP
VLS GROUND OPS WORKING GROUP

Senator **Bentsen**. Thank you, Dr. Cohen.

Mr. Frankle, if you would proceed, please.

Mr. **Frankle**. Thank you, Mr. Chairman and Senator Pressler.

I am pleased to be here today to address NASA's view of existing and potential barriers to the development of a successful and aggressive commercial space industry. I want to start my comments with an assurance that NASA is fully supportive of the industry and is committed to fostering and encouraging that industry to the extent possible under current law and policy.

I believe that NASA is at the leading edge of that policy and that implementation of it is proceeding rapidly and successfully.

For example, we are preparing for the selection of our first launch services contractor for the NOAA GOES I, J and K spacecraft this very month.

In addition, the current version of the fiscal year 1988 Authorization Act has a provision which I believe has wide support in both houses of Congress and would give us the legal authority we need to enter launch services contracts on a routine basis.

That authority will be very helpful in the commercialization of space and will be utilized immediately upon receipt.

It is, however, expressly designed for expendable launch vehicle service contracts, although it may provide an indirect model for encouragement of other industry segments.

We must be careful to recognize that, like any other industry, the developing commercial space industry is not monolithic. What may be a beneficial and positive policy toward one segment of the industry may actually be damaging to another.

An example of this would be that government efforts to assist companies interested in performing research and development in space flying for no cost under joint endeavor agreements with NASA could, if not carefully structured, have an impact on the ability of some commercial launch service providers to obtain payloads.

While NASA will not, of course, compete with private industry in providing any reasonably available service, there may be differences of opinion over what is in fact reasonably available.

In other words, the best way to encourage industry may not always be clear and some balancing of interests may be necessary.

Beyond the definitional questions of who is industry and what should be encouraged, several legal, policy, even physical barriers remain. Many of the possible legal barriers occur in the areas of fiscal law.

For example, the Anti-Deficiency Act prohibits an agency from assuming a contingent liability or assuming risk without specific legislative authority.

That same Act also may prevent an agency from obligating itself to pay for services in years for which funds are not yet available or from performing services for the industry without payment in advance.

Other fiscal doctrines, such as the bona fide need rule and the statutory prohibition against advance payments in most cases also limit an agency's flexibility in its approach to the developing industry.

Many of these problems will be solved for the launch services industry if our authorization bill becomes law.

In addition, the fact that government contracts are funded with appropriated money means that businesses are required to provide certified cost and pricing data and guaranteed audit access designed to insure that the government gets what it pays for.

Let me be very clear. I am not criticizing these requirements. The requirements will not prevent us from successfully dealing with the emerging commercial space industry. However, they do affect the extent to which the government can emulate a purely commercial transaction.

There are some policy concerns also. Necessary policies such as the policies against indemnification of commercial activities unless absolutely necessary, policies establishing priority for government activity and government owned assets, and the multitude of government policies that are expressed in the various provisions of the Federal Acquisition Regulation, creates a difficult thicket to penetrate in a commercial contractual vehicle.

The penetration can and will be done, but the resulting proposals may differ—and contracts, I might add, may differ significantly from their private sector counterparts. I am sure that the current policy can be supportive of the commercial launch services industry. I admit to some concern that it might work too well.

Under the current agreements being worked out with the Air Force and NASA, many companies will be relying on the government for services and use of the government facilities that are available.

These resources, however, are limited. While cooperation between the government and industry in this area is totally proper and in accordance with the Commercial Space Launch Act and the Administration's policy, I am concerned about the long-term prospects for an industry which relies upon the marginal availability of government-owned assets.

Current policy has worked and an excellent base now exists for the industry to start considering, with appropriate support from Congress and other policy makers, operations less dependent on the marginal availability of government assets.

Mr. Chairman, I am very optimistic. I believe the legal and policy barriers can and will be overcome. I think a great deal of progress has already been made in the agreements that have been signed to date, and others that are now in progress.

That does not mean there are not some areas of ambiguity remaining that may have an impact on the emerging industries and the government.

One such area springs quickly to mind, definition of the degree of insight that the government should have into the operation of a commercial operation.

Let me expand briefly upon this area. In a purely commercial contract for a service, there is no inherent right to a great depth of insight into the contractor's mode of operation. What counts is only that the service is performed.

With respect to launch vehicles and service, the standard has been different. Traditionally, the government had a great deal of insight into all phases of a contractor's operation in an effort to protect government resources.

In a purely commercial launch services contract, much of the information previously obtained by the government may not be available. The same quality records may not be kept, the government may not have access to those that are.

On the other hand, the launch service provider may well be able to provide the needed information. After all, it is making a very large investment in its operation and reliability is vital if the business is to succeed. It all comes down to a bottom line: What is a reasonable degree of insight into a launch services contract that is needed to protect very valuable, unique government payloads?

I don't know the answer yet. However, I believe it will be hammered out in negotiations over the next several years.

Mr. Chairman, I think we are in pretty good shape. We know what the issues are to be solved and we are working to solve them.

As we proceed, the expectations of all parties, the industry, the Congress, and the Executive Branch, will become clear and we will move ahead together.

Mr. Chairman, we at NASA are enthusiastic about this prospect and we look forward to the development of a successful domestic space industry.

We think the time is right to examine the short- and long-term barriers to the industry and to make intelligent decisions that will foster and encourage commercial space activity.

I would be pleased to answer any questions you may have, Senator.

Senator BENTSEN. Thank you, Mr. Frankle. That is a very thoughtful statement and does provoke some questions.

Dr. Cohen, let me start with you, as the Center's Director. We have heard a lot of comments about the content and the objectives of the space program and the commercialization thereof.

Now, as the Director of the Johnson Space Center, in interpreting that commercial space policy, for example, can you provide both direct and indirect support?

Mr. COHEN. Yes, I can, sir. In interpreting that, we can provide both direct and indirect support. Of course, we do have limited resources, but within the resources we have, if we go through a process, we do provide indirect and direct support and we are very happy to do that, and we have done that in the past and we will continue to do that.

Senator BENTSEN. Mr. Frankle, when you talk about the marginal support, the marginal ability of government assets to contribute to the effort on commercialization, we run into the problem, of course, that—and I have seen this so much in the trade problem we are having with other countries, that so often we have our companies competing against countries, and it is the public sector on the other side, or the government sector competing against the private sector here.

You are talking about an area that is very much a new frontier, high risk, no question in my mind but what there has to be is an interaction and a cooperation between government and the private sector in the commercialization of space. This is particularly so in the beginning, because they must have the means to cushion that kind of an exposure, it seems to me.

Would you care to comment on that?

Mr. **Frankle**. I agree absolutely with what you say, Senator. I believe that there is a need, especially in the beginning, for assistance. My only concern is that we not put ourselves in a paradoxical situation, that is, if the American industry succeeds and starts capturing a large portion of some business, their ability to grow should not be limited by their reliance upon the government assets that are used for other things.

I believe that we have some time. For instance, I think it will be a some time before, the commercial space launch industry outgrows the capability of the government assets and launch facilities to handle what they need. However, it is important that we not allow ourselves to be in a self-defeating situation.

Senator **Bentsen**. Well, I was looking at the National Security Decision Directive 254, which is the basis of the nation's space policy, stating that the space shuttle will be phased out from providing launch services for commercial and foreign payloads that do not require man's presence or the unique capabilities of the space shuttle.

Now, realizing that this space center interacts significantly with potential commercial customers, does not this directive adversely impact a significant portion of the potential commercial space market, and what kind of wiggle room do you have in that? Either one of you.

Mr. **Cohen**. Well, I will take a crack at it. There is no question that it does change the path that people are going down, so it does alter some payloads that were going to fly on the shuttle. In other words, now we look at foreign policy decisions, national security decisions, and, as you stated, the uniqueness of the payload that flies on the shuttle that needs man's attention, or human attention to it.

So it does alter that, and what kind of impact that causes in the industry, I really cannot say specifically. I think it certainly causes some.

The wiggle room, so to speak, I think really has to be looked at, really on an almost individual payload-by-payload basis. I think there is some there, but it certainly has to be reviewed on that basis. That would be my assessment of the situation today.

Senator **Bentsen**. Do you have anything to add to that, Mr. Frankle?

Mr. **Frankle**. Yes, Senator. I mentioned in my statement the need to recognize that we do not have a monolithic industry. I think that the decision in NSD 254 would be cited by some people as the necessary spark that was needed to get the United States into the commercial space launch business.

At the same time, it clearly did have an impact on the ability of the U.S. satellite manufacturers to get their satellites launched in a timely and inexpensive manner.

These are very tough policy calls, and it requires a balancing, I think, that is going to strain our resources and talents of everyone over the next few years.

Senator **Bentsen**. Well, as general counsel, let me ask you the next one, then.

We are going to get some testimony later about the degree of risk involved and the availability of insurance to protect the private sector company.

Yet, a key element of the nation's commercial space program has been that the private sector was willing to take all the risks, but I am beginning to wonder if it can, in the initiation of some of these programs.

Do you think that there is a foundation here for some types of risk-sharing arrangements required with NASA participation?

Let us take an example. Let us suppose we have a situation where a company can get $100 million, $200 million worth of liability insurance, and that is all they can get, but you can have an incident that goes beyond that and you have had at least partial utilization of government facilities.

Investors may feel that is something they do not want to get into if they do not have full coverage for accidents.

Would you comment on that?

Mr. **Frankle**. Yes, Senator. As you are aware, for the last several years NASA has had some authority to indemnify the commercial users of the space shuttle and NASA launch vehicles. We have used that to provide indemnification over and above some required level of insurance.

I think that is slightly different than what we are facing now in that the vehicles that were being flown were NASA vehicles; they were run by NASA employees and they were built to NASA standards, again with the insight that I was talking about before.

Because of that insight, as we move to the reliance on the commercial launch sector, NASA will lose that insight into the vehicles, and as such, I am not at all certain I see why NASA should be the entity providing any such indemnification or insurance.

We had some control over the risk in the past. We would not necessarily have some role in controlling the risk in the future.

I have absolutely no objection, from the legal standpoint, of somebody in government providing that type of assistance; I am just not certain it should be NASA, but perhaps there should be some other agency that has some ability to control the risk.

Senator **Bentsen**. I appreciate that, and I sympathize with your voice problem.

I must tell you that, in an aside, in questioning witnesses, I can remember Arthur Burns, when he was Chief Economic Adviser for the President, if you asked him a real tough one, all of a sudden he would pull out his pipe and spend some time stuffing his pipe.

And if you did that to Paul Volker, he would pull out a cigar and light up his cigar and then finally, out of that cloud of smoke, he would give you an answer.

Bobby Inman, if we had him before the Intelligence Committee, and you gave him a tough question, he would reach down and pull up his socks.

Mr. **Cohen**. Senator Bentsen.

Senator **Bentsen**. Yes.

Mr. **Cohen**. I would like to give you my perspective of it. It is not from the financial point of view, but it is from the point of view from my perspective.

I think there are basically three types of risks that I see. One is the research risk, and I think NASA does share that risk by doing basic research and by doing the things you asked me about later, about using our expertise and our help and our facilities. So I think we do share that risk, and I think that it is important that we do. Some of the things we are doing today are exemplified by that.

Then there is, you might say, the business risk. The business risk is—and not being a businessman, but there is business risk. But we do things like we do not compete for certain things and we do defer payments for certain things. So I think that is important.

Then there is the operations risk, which we do share in by using our capabilities and our talent of our operations and engineering people to help, so I think, in my perspective, there are three types of risks that we do share, and I cannot answer the other, but that is from my perspective.

Senator **Bentsen**. Thank you. I have used my time.

Senator Pressler.

Senator **Pressler**. I would like to ask each of you a broad overview question, somewhat philosophic, on this whole subject of space commercialization, and that is, is the commercialization of space just a cop-out for the government which is unwilling to do its job, or is it something that is really going to happen.

Now, for example, an example of the government's attempt to commercialize an existing asset is the initiative to commercialize Landsat, our satellite land remote sensing system. Yet this initiative has, by all counts, been a failure to date, and in my judgment it has been a failure, in part, because the government has not lived up to its part of the bargain, and for other reasons.

How sincere is the government in commercializing space, or is it just a way to slim down our space program and off-load certain activities?

Mr. **Cohen**. Well, I think, as I have looked through this through the years, being in the space program a long time, I think the fundamental premise for space is really to try to solve humans' problems on Earth from space. I think that has one of the fundamental premises, and I think in that there has got to be a commercial aspect to that.

So I think it is real. I think what we need to do to get on with it is to give a signal to the country and to our entrepreneurs in the country that we are serious about it.

By that I mean, there's no question in my mind that we need to return the shuttle to flight; we need to get the replacement Orbiter; we need to have a space station, and we need to let people know that there is no question we are going to have that capability.

We cannot say we are going to do it and not do it. We have got to let people know we are going to do it. We must move on with it in a very rigorous fashion.

I think the commercialization and the entrepreneurs will take advantage of that, and I think it is real.

Mr. **Frankle**. I also believe it is real, Senator, and that we are doing what we can. I am not totally certain what the causes were for the problem with Landsat, but I think that we now are facing a new development of a new type of industry rather than a spin-off of something else and that different results will occur.

Senator **Pressler**. What will be the consequences if this space commercialization initiative does not succeed?

Mr. **Cohen**. I think, as Senator Bentsen stated in his opening remarks, that the competition from other places will do that. If we do not do it, somebody else is going to do it. I think it is very important that we do it, because it is going to take place, and I think we will lose out in the competition if we do not take hold.

I feel that Senator Bentsen's statement on that issue is correct, and I agree very strongly with him. That is my personal feeling.

Mr. **Frankle**. I agree entirely, Senator. I think it is just a question of what language the people doing it are going to speak.

Senator **Pressler**. Now, Mr. Frankle, according to your testimony, there are a number of fiscal laws that are barriers to commercial space activities as they relate to the government as the customer.

You mentioned, among other things, the act that prevents an agency from assuming contingent liability and that prohibits an agency from exercising multiyear procurement authority.

Could you describe specifically how these and other fiscal laws are affecting adversely the commercial development of space and how they are limiting NASA's ability to promote and encourage space commercialization?

Mr. **Frankle**. Yes, Senator. I have been trying to do as much study as I could of commercial contracts for launch vehicles and other situations like that.

Most commercial contracts require things like payment schedules, which are paid where you pay up front on a schedule, not on milestones. The customer does not obtain title to the goods that are being prepared for, in this case, a commercial space launch.

Those kind of payments normally would violate advance payment prohibitions. It would probably incur obligations against appropriations that have not yet been made, and therefore that would violate a law.

In NASA's case, we normally obtain two-year funds that we would use. The use of 2-year funds for a service that we are not going to obtain for maybe 3 or 4 years, because many of the payment schedules are 36 and 48 months, would violate the rules about the use of limited year funds because you are required to use those funds for bona fide needs of the fiscal years for which they are appropriated.

In addition, there are contingent liabilities. What happens if in fact the government has to terminate a contract if one or more of the payloads that we are planning to launch does not materialize? We conceivably could run into a liability for more funds than have already been appropriated. That would also violate the law.

All of these provisions, these types of things, keep us from entering into what is a fairly standard commercial contract for launch vehicle services. The same criteria apply in other type contracts whenever we are using appropriated funds.

There are various ways of dealing with it. Legislatively is certainly one of the better ones. Other ways would be providing different type funds so that all the programs would be fully funded in advance with no year funds. However, that usually is not seen as a good idea in increasing budget authority fairly significantly right now.

So there are some problems that keep us from reacting in ways that we might like to otherwise.

Senator **Pressler**. What recommendations, specifically, do you have to change these fiscal laws to facilitate and encourage commercial space development?

Mr. **Frankle**. Well, the provision that is currently residing in our proposed authorization bill addresses each one of these specific items with respect to contracts for expendable launch vehicle services.

If we are to enter into those kinds of contracts, it is vital to have that language, and we need it quickly.

It is not as clear when we get to exactly what language we need when we get to other than commercial launch services contracts. But I think similar type authorities will be required as our contracts for the other commercial type services and/or products come along, and I think we can use the language that we are hoping to get under the Authorization Act as a model for how to proceed.

Senator **Pressler**. Mr. Cohen, in your testimony you mentioned the five centers for the commercial development of space with which JSC is associated.

What are the standards of success by which these centers are measured and how are these centers performing to date?

Mr. **Cohen**. Well, the standard of success is going to be one of can they really develop the technology that industry is interested in.

I think a good part of that program is that it ties three things together that in my mind are extremely important, academia, industry and government. To me, that is a good combination to make things happen.

The standard is going to be, as the seed money that NASA puts into these centers, if they really do a good job, industry is going to want to put more money into it because they look like they have a product that is going to pay off for industry. So that is going to be the true measure of success.

How well it is doing, I personally think it is going to do very well. I think it is a little too early to give you a grade D report card on it, but to me it is a good combination and I am looking at this as a very positive thing.

So I think it is going to be good, but it is too early to tell, sir.

Senator **Pressler**. Now, some members of our domestic ELV industry are seeking to have the government fully indemnify U.S. ELV companies above a minimum level of insurance that each launching company could purchase, because the governments of foreign ELV companies can, by and large, indemnify their national ELV launch entities against all third-party liability claims.

Consequently, our domestic ELV companies believe they are at a competitive disadvantage if they have to purchase this insurance.

What effect, to date, has this had on our domestic ELV companies and how will it affect them in the future? What are the factors that must be considered in deciding if the government should fully indemnify against third-party claims?

Mr. **Frankle**. Senator, clearly, our competitors are dealing with some indemnification, Arianespace is indemnified by the French Government for claims, third-party liability over 400 million francs, which I think is in the vicinity of $120 million.

The industry has clearly expressed a desire for such protection. I again do not have any real strong objection to that type of protection if it is needed. I am not sure it has been demonstrated yet that it has been needed.

There are contracts that are coming in, it seems, in reasonable numbers to the launch service providers. If it can be shown to be a deterrent to the industry and that there is basically an unfair competition which is harming it, I do not think that we at NASA would oppose that. I do think that would require a legislative solution.

Senator **Pressler**. In terms of what we are talking about, I will address this to Mr. Frankle. In your testimony you referred to a provision in the Commercial Space Launch Act which prohibits direct subsidies to companies providing commercial launch services.

Maybe we should go to direct subsidies; at this point I am uncertain. In your opinion, should this general position be reconsidered, and if so, should we consider providing direct or indirect subsidies to commercial space ventures?

If so, what factors would have to be considered in determining the nature and magnitude of any subsidy? I know that subsidy is a bad word in Washington, unless, of course, you are talking about farm payments.

What is your view of that? I will ask that of both of you.

Mr. **Frankle**. Subsidies are not my area, Senator. I know that they have ramifications that go all the way through the economy and also internationally, and I just feel that if something like that is going to be done, you should be real careful about it and make sure that it is really needed before something is done.

I do not think that there has been demonstrated yet an actual need for such a thing.

Mr. **Cohen**. Senator, I am not sure I am an expert on that subject. It is a very complicated subject, and I am not really sure. I personally think that if we can provide the facilities and do the type of risk management that I discussed earlier, I am not sure what more is needed. I am really not an expert in that field however.

Senator **Pressler**. Mr. Cohen and Mr. Frankle, your testimonies and responses will be of great assistance to this Committee as we considers our nation's efforts to commercialize space. As I mentioned in my opening statement, we have a number of hurdles to clean to realize the true potential of space commercialzation, but public debates such as today's will help negotiate these hurdles. I thank both of you very much for being here today.

Senator **Bentsen**. Thank you very much.

Gentlemen, your testimony has been very helpful and we are appreciative. Thank you very much.

Mr. **Frankle**. Sorry for the voice problem, Senator.

Senator **Bentsen**. Oh, well, I have had it many times myself.

Our next witnesses will be Mr. Walter Cunningham, who is Chairman of the Aerospace and Technology Committee of the Houston Chamber, and Dr. David J. Norton, Director of Space Technology and Research Center.

Mr. Cunningham and Dr. Norton, we are really pleased to have you before the subcommittee today, and you are certainly well qualified to talk about the economic potential of space activities and give us some first-hand impressions from the business and from the R&D communities.

I am most interested to hear about the economic potential of space and better understand how we can help ensure the transfer of technology from the R&D to the business sector, and I mean the U.S. business sector.

Mr. Cunningham, if you will proceed first with your prepared remarks, and then we will hear from Dr. Norton, and then we will open it up to questions.

STATEMENT OF R. WALTER CUNNINGHAM, CHAIRMAN, AEROSPACE AND TECHNOLOGY COMMITTEE, HOUSTON CHAMBER OF COMMERCE

Mr. **Cunningham**. Thank you, Senator. Senator Bentsen, Senator Pressler, thank you for the opportunity to present my views before your subcommittee this morning.

I speak to you from the perspective of a technologist and a venture capitalist who believes in the marketplace and recognizes the conflict of interests in the private sector that was mentioned to you earlier by Mr. Frankle.

There is no question but that we must encourage the commercial exploitation of the space environment. The Soviet Union, France, China, Japan, and others, know this commitment is necessary if they are to remain among the leading nations of the world.

This is an opportune time, when delays in the shuttle program allow us time to reassess, with minimum impact our earlier initiatives to promote space commercialization.

While a Commerce in Space Act is extremely important, it is not necessary to reinvent the wheel. We have a number of models in recent history from which to draw and which are consistent with our free enterprise system, the Civil Aeronautics Authority, commercial jet liners, semi-conductors and yes, expendable boosters as well.

If you look at the Boeing jet liners that are flowing from the government development of the B–52 and the KC–135 you will see the nature of the examples I am citing.

Today, a number of nations are aggressively pursuing commercially profitable opportunities in space. Space offers enormous opportunities for new products, technologies and whole new industries.

It is essential that the U.S. maintain leadership in this field. The Commerce in Space Act can be a step in the right direction in commercial areas.

There is a commercial pay-off in space, but with the exception of communication satellites, no one seems to have found it yet.

With new alloys, polymers, pharmaceuticals, ceramics, sensors, semi-conductors, and other high-value materials, a competitive position in a global market is at stake, but it is simply too expensive to put things into orbit at this time.

The cost to put a pound into orbit dictates that only those opportunities offering the very highest returns fly in space today.

Companies and entrepreneurs cannot be pushed into investing. They have to be pulled along with a capability or an idea that will make them want to put their own time, energy and money into it.

If there is a profit to be made in space commercialization, there are people willing to pursue the investment and to exploit it.

If there is not a profit in space today or tomorrow, then all of the government bureaucracy and offices in the world are not going to help that process.

In the commercial arena, NASA should support the private sector by developing the technology, developing the launch vehicles and the space infrastructure for the private sector to use.

NASA should work to lower the cost of putting a pound of payload into orbit and leave to the private sector the problem of commercial exploitation of the space environment.

There are a variety of categories of commercial activities. I list three here, which is the way I tend to categorize them.

First is private launch services and large private boosters. My feeling is that perhaps some day there will be a privately developed booster, maybe one or two decades hence, but our nation needs assured access to space via the shuttle, expendable launch vehicles and a heavy-lift vehicle today.

The long lead times, extremely high cost, safety and reliability requirements, and national security considerations may dictate that launch vehicle development remain, at least for now, an exclusive government province.

The launch vehicles in use by the private sector today, the Titan, the Atlas and Delta, have all been developed at government expense, with the space transportation system, the space shuttle, being more expensive than any other.

Martin Marietta, General Dynamics and McDonnell Douglas are competing in the marketplace today because of this government subsidized development.

Newer and smaller companies will have to do as entrepreneurs have always done, they will have to find a market niche. The government can help by making available launch facilities, helping to prove out the market, and providing as cheap transportation as possible.

Second, privately owned satellites and other commercial payloads, they should be able to fly on government launch vehicles at a cost as low or lower than they could by hiring foreign launch services.

In most cases, this will probably mean a subsidy of some sort. The government could also accommodate pilot projects at bargain prices.

Third, a principal question remains today, government pricing of launch services for the space shuttle and expendable launch vehicles.

There is a relatively simple answer, I believe. The marketplace for launch services is world wide. The United States has spent $100 billion to develop the best technology and the most reliable track record.

We should compete for the biggest market share of launch and payload services world wide. To accomplish this, we must be price competitive with any comparable launch service from around the world, taking schedules into account.

It is estimated that today there is a $500 million commercial launch service market out there, and to my knowledge, the French company Ariane Space has more than 50 percent of that market share at the present time. That seems silly, given our relative backgrounds.

This, in effect, is a major area for subsidization by the government and is the same area where competing nations provide subsidies.

To address the question that Senator Pressler asked earlier about direct or indirect subsidies, indirect is what I would favor.

If we must price a shuttle launch at $50 million to compete with the French Ariane, then so be it. If we price it at $150 million to fully amortize development costs and subsidize private launch services in this country, then we will only drive the business offshore and run the costs for domestic launches even higher.

This world market price, or better, should be available to private payload operators in the United States.

The military establishment of the United States should be a prime customer for government launch services. The transfer pricing for military payloads should be an attractive and cost effective alternative to any military duplication of facilities.

Sad to say, I believe we probably do face some inefficiencies because of duplication of facilities today.

In the area of some direct recommendations, I think any Space Commerce Act must take into account the collateral commerce created on Earth here by space commercialization.

I reference the paper provided to the committee earlier on the Johnson Space Center's impact on Houston and Texas. Of about $1.8 billion spent annually here, probably half of it is spent locally, and it has tremendous impact on the Houston area.

The government's role should be to help prove up the market and remove any obstacles to private sector participation.

The private sector's role should remain exploiting that market whenever possible.

Any new government initiatives should be even-handed. They should encourage all entrepreneurs equally. Any subsidies should be generic in nature and not provided to specific individuals or companies.

The necessary space infrastructure for the United States cannot be properly defined and developed with any coherency if our policy is on-again-off-again or neglected or fuzzy beyond recognition.

We need a stable space policy that transcends political fluctuations in order for business to make financial commitments for commercial exploitation.

We will not be able to maintain or recover civil space leadership without assured, consistent, multi-year funding. The real commercial successes must be market driven, and markets are frequently a function of costs.

The most significant cost in this case remains the transportation system, and it is the government's job, I think, to try to bring down the cost of transportation.

Thank you.

Senator BENTSEN. Thank you. You really dealt in some specifics, and that will be helpful.

Mr. Norton, if you would proceed, please.

STATEMENT OF DAVID J. NORTON, DIRECTOR, SPACE TECHNOLOGY AND RESEARCH CENTER, HOUSTON AREA RESEARCH CENTER

Mr. NORTON. Thank you. Senator Bentsen, Senator Pressler, I am very pleased to be able to participate in these hearings today, to present testimony on the value of commercial space from the perspective of a research consortium dedicated to providing intellectual capital in the diversification of the economy through technology.

As you know, Senator Bentsen, the Houston Area Research Center was created through the foresight of four of the most important research universities of Texas, including Rice, Texas A&M University, the University of Houston and the University of Texas at Austin, and it is an outreach to business and government.

HARC is organized as a private, nonprofit corporation, reporting to an independent Board of Directors taken from university and industry.

As such, HARC operates in a private sector environment and it is structured to respond to industries and technologies.

As Americans, our know-how has earned us a standard of living which is second to none. Today, know-how has a different name, it's called technology, and it is through technology and its use that we sustain the American way of life.

While there are other factors, it is through technology we are able to offer competitive products and services in a global marketplace. To the degree that we are successful in translating research into technology, and technology into products, we generate a favorable balance of trade and a robust economy.

Technology then is a key to the generation of wealth as surely as natural resources have been in our past.

Ultimately, the generation of technology is a harvest of ideas from people. This resource is renewable and fundamental but is not explicitly covered by any one government agency.

In fact, because of the various facets of the process by which new ideas are conceived, nurtured, harvested and converted to fuel for our economy, they fall into different institutions in our society.

Because in the past these institutions have coexisted but not been integrated, we do not have a very cohesive system by which we optimize the potential return from ideas.

What are these institutions? Well, it is an educational system funded by states, a basic research system funded by government but keyed to research in defense, and the private sector, which operates at arm's length from both of those two, but which is expected to create the wealth that supports all of them.

In the post-*Challenger* era, a more sophisticated public is asking to understand the connection between federal technology programs and the economy.

Space is the most visible case in point and it has had a long duration. Increasingly, people want their space program to be more than expeditions to impress, and more than spin-offs. They want the civil space program to demonstrate that it can bring education, government and industry together in some new ways to directly address the economy through technology.

In regards to the infrastructure which I think is critical, today the commercial space bell is being rung for a second time. The first time we simply were not ready to respond or to accept private space.

The infrastructure was not there, and I mean by that, the people were not there, the laws were not there, the policies were not there, and lastly, the hardware was not there.

I am so pleased that today that we are beginning to consider the laws and the policies that will enable us to make use in some effective way of our investments in the past.

Texas and Houston have been at the forefront of the movement to define commercial space development. I suppose that is one reason why you are here today.

Many of the most innovative space ventures, some of which you will be hearing from in a minute, have their origins here. Texas has established for itself a Texas Space Science Industry Commission.

The Houston Chamber of Commerce has created the Aerospace and Technology Committee. The Houston Economic Development Council has chosen commercial space as one dimension for diversification.

The Space Foundation, which is dedicated to space business, was started here 10 years ago and now has some eight Space Business Roundtables across this nation.

The universities have demonstrated a keen interest in research for space commerce through NASA's centers for the commercial development of space.

Currently, the University for Houston and Texas A&M are functioning in this capacity, with significant industrial collaboration.

At STAR Center, a division of HARC, we have created the Space Development Laboratory, dedicated to a private sector vision for commercial space and the direct support of entrepreneurial space ventures.

Some of the most fundamental industries and utilities of the region are participating in that. Taken together, all these things are the people which are now in place and enthusiastic to participate.

Now that the notion of commercial space development has had a chance to mature for a decade, a well conceived Commerce in Space Act could be the basis in law to define the responsibilities and the funding which will allow us to take competitive advantage of space.

The act should not preselect which ventures which should be initiated, but rather leave the door open for any. This act should further result in mechanisms by which the private sector can utilize government and university without forcing either upon them.

It will be important that government be a partner along with private sector, because this field has been targeted by other nations who have demonstrated industry-government cooperation in establishing markets.

In the hardware category, the key issues are low cost access to space, a place to do business and a way to return. There can be nothing more fundamental to that than a schedulable, low cost, reliable transportation system.

We must never again preclude access to space by relying on monopolies of any origin. Reductions in the real cost will come through research and the reduction of personnel required to effect the launch.

Government should lead in research, but the private sector will probably be able to deal with the personnel issues more efficiently.

The space station is a key element of the hardware of the necessary infrastructure, and will probably be the anchor tenant of what I envisage as a space mall in which there will be many other tenants, including space industries, industrial space facility.

Beyond that, it is entirely conceivable that there will be the need for space utilities, for power, communications and computing. Indeed, Texas A&M has taken on, through their commercial development of space, a power system that will attempt to bring commercial power to space.

In conclusion, the commercial development of space is a complex issue which is forcing us to look at some basic tenets of how we are organized.

I think what is needed is a way to pull a thread through our major social institutions for research and for technology development and for the private sector so that we end up with a system that takes research and makes it into economic wealth, which we need to fund education and defense.

Second, the Act should consider providing mechanisms by which not only large companies receive the benefits but small companies receive the benefits and have access to the intellectual capabilities of government and universities.

[The statement follows:]

STATEMENT

OF

DAVID J. NORTON, DIRECTOR

SPACE TECHNOLOGY AND RESEARCH CENTER

HOUSTON AREA RESEARCH CENTER

My name is David Norton, Director of the Space Technology and Research (STAR) Center which functions as a division of the Houston Area Research Center (HARC). I am very pleased to participate in these hearings to present testimony on the value of commercial space from the perspective of a research consortium dedicated to providing intellectual capital in the diversification of the economy through technology.

The Houston Area Research Center was created through the foresight of four of the most important research universities of Texas (Rice University, Texas A&M University, The University of Houston, and the University of Texas at Austin) as an outreach to business and government. HARC is organized as a private, non-profit corporation reporting to an independent Board of Directors taken from university and industry. As such, HARC operates in the private sector and is structured to respond to industries and technologies as opposed to educational disciplines and basic research which are roles of the university.

As Americans, our "know how" has earned us a standard of living which is second to none. Today "know how" has a different name--technology. It is technology and its use which sustains the American way of life. While there are other factors, it is through technology we are able to offer competitive products and services in the global marketplace. To the degree we are successful in translating research into technology and technology into products, we generate a favorable balance of trade and a robust economy.

Technology is then a key to the generation of wealth as surely as natural resources were in the past. Ultimately the generation of technology is a harvest of ideas of people. This resource is renewable and fundamental but is not explicitly covered by any one government agency. In fact, because the various facets of the process by which new ideas are conceived, nurtured, harvested and converted to fuel for our economy falls into different institutions in our society. Because in the past these institutions have coexisted but have not been integrated, we don't have a very cohesive system for optimizing the potential return. And what are these institutions? They are the educational system funded almost entirely by the states, basic research system almost entirely funded by the federal government but keyed on defense, and the private sector which operates at arms length from the first two but which is expected to create the wealth for all.

Space has been a great technological adventure for the United States in which we have invested over one hundred billion dollars. Over the years, the federal leadership in this area has switched between the military and NASA. Each have contributed a great deal to the know how (technology) of space but currently DoD outspends NASA by over 2:1. Of course, the military is not charged with enhancing the economy of the nation and is in fact, leery of the transfer of sensitive technology into the global domain. In the past, NASA has responded to direction from the President and has enjoyed broad public support in what we have called the civil space. Now NASA is developing its strategy to best serve the nation; surely this strategy will be cognizant of the role it can play in stimulating the economy through technology and the commerce which can result.

In the post Challenger era, a more sophisticated public is asking to understand the connection between federal technology programs and the economy. Space is the most visible and the longest in duration. Increasingly people want their space program then to be more than expenditions to impress and more than spin-offs; they want at least the civil space program to demonstrate that it can bring education, government and industry together in some new ways which directly address the economy through technology. In this new experiment, exploration is important, science is fundamental, but technology which translates to American "know how" is a central theme.

Infrastructure

Today, the commercial space bell is being rung for a second time. The first time we weren't really ready to accept private space. Furthermore, the necessary infrastructure was not in place. We need now to create an infrastructure of people, law, policy and hardware which will make space the domain of corporations and individuals instead of governments. If this infrastructure is well crafted the genius of the American system can come to bear on space as it has in so many other arenas such as: aviation, telecommunications and computers.

Texas and Houston have been at the forefront of the movement to define commercial space development. Many of the most innovative space ventures, some of which are testifying today, have their origins here. Texas has established a Space Science Industry Commission. The Houston Chamber of Commerce has created the Aerospace and Technology Committee and the Houston Economic Development Council has chosen commercial space as one dimension of its diversification effort. The Space Foundation which is dedicated to space business was started here ten years ago and now has some eight Space Business Roundtables around the nation.

The universities have demonstrated a keen interest in research for space commerce through NASA's Centers for the Commercial Development of Space. Currently the University of Houston and Texas A&M University are functioning in this capacity with significant industrial collaboration. At STAR Center, we have created the Space Development Laboratory dedicated to a private sector vision of commercial space and direct support of entrepreneurial space ventures. Some of the most fundamental industries and utilities of the region are participating. Taken together the people represented in these activities constitute a very real part of the infrastructure for commercial space development.

Now that the notion of commercial space development has had a chance to mature for a decade, a well conceived Commerce in Space Act could be the basis in law to define the responsibilities and funding which will allow us to take competitive advantage of space. This act should strive to develop a model structure by which federal technology expenditures result in the improvement of our economic competitive position. The act should not preselect which ventures should be initiated but rather leave the door open for any. This act should further result in mechanisms by which the private sector can utilize government and university without forcing either upon them. It will be important that the government be a partner along with the private sector because this field has been targeted by other nations who have demonstrated industry/government cooperation in establishing markets. Further, the questions of insurance, indemnification, launch facilities, safety and regulation of competition will require proactive government support if our industries are to compete.

In the hardware category the key issues are low cost access to space, a place to do business and a way to return. There can be nothing more fundamental than schedulable, low cost, reliable space transporation. We must never again preclude access to space by relying on monopolies of any origin. Reductions in the real cost will come through research and a reduction of personnel required to effect the launch. Government should lead in this research, but the private sector is more capable of dealing with real bottom line costs, especially if the incentive for profit is there.

The Space Station is a key element of the hardware part of the necessary infrastructure and probably the anchor tenant of a "space mall" which will serve the marketplace. Undoubtedly the Space Station will serve the scientific and research needs but potentially many other government functions as well as commerce. Other tenants will include such innovative ideas as the Industrial Space Facility which is currently under development by the private sector partnership headed by Space Industries and including Westinghouse and Boeing. Beyond this it is entirely conceivable that there will be a need for space utilities for power, communications and computing. Indeed, the Texas A&M Center for the Commercial Development of Space will be tackling the commercial space power issue.

There is no reason why power in space can't be provided by the private sector, indeed the nation has everything to gain by encouraging low-cost space power because to really do space manufacturing will require much more power than our current solar panels can generate. Besides, think of the weight and bulk which could be eliminated from satellites large and small by supplying from space the power needed for electricity and orbit keeping.

Conclusions

The commercial development of space is a complex issue which is forcing us to look at some basic tenets of how we are organized. Based upon the massive investments we have made in space technology, it is resonable to use space as case in point. If there is no commercial value in space, why should we have civil technology programs? Furthermore, in the fact of limited financial resources it is necessary to ask, "can we afford to have our major social institutions work independently?" Now may be the time to establish that even space must have its bottom line. A good measure of that bottom line, I believe, is in a civil program which develops technology which impacts the economy. Within that context, commercial space is a natural and could carry on in the tradition of aviation and deliver many of the benefits that it provides.

A Commerce in Space Act could play an important role in getting the American team of education, government and industry working together. The act will be most effective in the long run if it permits the private sector to leverage from the federal government and establishes space commerce as a major objective of our civil space program. That vision is much more than growing a crystal in space. It envisages private ownership of transporation systems, power systems, communications systems and places where people work and live.

Senator BENTSEN. Thank you very much, Dr. Norton.

Mr. Cunningham, I recently read a report of the Houston Chamber of Commerce concerning the role of the Johnson Space Center and the economic impact it has on Texas, and I was very pleased with the report, which shows Texas in a leading role in the space effort and that it is an integral part of the Texas economy.

A U.S. Senator has a dual responsibility; one of them to look to the concerns of his nation, and the other one, of course, to the concerns of his state.

This state of ours has taken some pretty tough hits lately, so let me be a little provincial here.

One of the things that disturbed me in the report was the lack of growth of the space manufacturing units in this particular area.

Do the other centers around the country have the same kind of a problem, and if they do or they do not, what can we do to try to turn this around here in Texas?

I look at this number of companies that we are discussing here today, Space Industries, Space Services, Inc., Orbital Sciences Corporation, will they result in manufacturing jobs in this area?

What is being done by Texas companies, existing firms, to diversity, to compete for government contracts, for elements of the major space industries?

Mr. CUNNINGHAM. Senator, you are asking a question that was one of the reasons why we initiated and kicked off the Aerospace and Technology Committee of the Chamber approximately 18 months ago.

It became obvious that during the heyday of the energy industry that here in Houston, as in the rest of Texas, we did not go out and aggressively pursue a lot of diversification.

That is an issue that is being addressed, I think, very aggressively today, and we think it is going to effect some changes.

The Johnson Space Center budget, which represents approximately 25 percent of NASA's budget annually—about $1.8 billion in the last fiscal year—and approximately 25 percent of that is spent locally. The reason that more has not been spent here historically is because the aerospace contractors have tended to cluster in the northeast and southern California, as you are aware, and a great number of those companies have just routinely spent their money where their home is.

An effort is ongoing today in the Chamber and in the Houston Economic Development Council, and in some of the agencies that Dave Norton has mentioned, statewide, to get more of those dollars spent locally.

There have been colloquiums, there have been symposiums held locally to talk to local manufacturing facilities. We have a tremendous capability here in small manufacturing and machine activities, but those people did not really know how to do business with the Federal Government.

So the Aerospace and Technology Committee of the Chamber has a subcommittee that addresses getting more direct government contract work. That is being addressed by an education process and what I would call, frankly, a lobbying process.

Senator BENTSEN. I noted in your comments that you take exception, really, to the Administration's policy of no direct or indirect subsidies for the commercial space activities and that you clearly favor a generic approach, not aimed at any one particular firm but at all firms for the private sector.

What types of subsidies would you be talking about? You were talking about the transportation part of it. Are you talking about any kind of price supports, are you talking about purchase agreements, are you talking about loan guarantees, are you talking about tax incentives, or are you speaking purely to the transportation part of it?

Mr. CUNNINGHAM. My personal belief is that NASA has the responsibility to develop the technology, as they have done over the years.

I believe that the controversy that has developed of late as to what the private sector should be charged for that kind of technology is an issue that needs to be faced. It represents a conflict of interests in various factions of the commercial space sector.

In my opinion, we cannot afford to let the launch services around the world, or even particularly the U.S. companies, to be out hiring foreign launch services.

As we know, there is even an ongoing effort by the Soviet Union to come in and price, very conveniently, U.S. launch services. I think it is criminal for us to be in a position of having to consider that.

I think General Motors recently requested to use a Soviet launch vehicle. Now, the reason they are turning in that direction is twofold.

One is at least those vehicles are out there flying right today, so our number one priority has to be—get back in the air and flying. We have to do it with a diversity of launch vehicles.

Another factor, of course, is the cost. When you look at the Chinese talking about launching for $20 million and doing their own insuring, that is tough competition.

We need to recognize that this country must maintain its leadership position by maintaining a major market share of the worldwide launch services. So we must price that service to be competitive.

I look at that, and while I am fundamentally against subsidies, I find that this is an area where I have to compromise my feelings. It is important that the government price launch services to get that business.

When it comes down to working with other contractors, I know that NASA (the government through NASA) is pricing things and attempting to make economic concessions and incentives to companies like Space Industries, Inc., and others in which they are signing joint endeavor agreements.

If we have to make concessions, we need to do it in a way that does not favor one particular individual or company over another.

In this country, another area that we need to recognize is that small entrepreneurs are going to be the key to finding ways of making space pay.

In this country, as opposed to, say, the Soviet Union, we will not be able to have the money flowing into the space sector until we get full commercial participation.

It is not like a system of government where policy is dictated from the top down.

Senator **Bentsen**. Mr. Cunningham, I could not agree with you more on that. Unless Congress can see the commercialization and the payoff here and that it is helping us on our trade, where it is helping us on standards of living, where we can see the actual results that benefit the citizens of this country, you are not going to have that kind of support for the program. You are right.

Mr. **Cunningham**. That is right.

Senator **Bentsen**. Give me some feel, if you can, if you were to reach out there, if we do serious commercialization of space, what kind of an impact do you see for this area that is seeking diversification?

What areas do you think in particular will move?

Mr. **Cunningham**. Well, we are already seeing, flowing out of the technology that has been developed at NASA, we see a tremendous transference into the medical industry, for example.

There are people that cite as many as 20,000 direct new technologies and products flowing out of the space development so far, over the last 25 years.

I do not know whether those numbers are accurate or not. I do know that from the point of view of venture capital and entrepreneurs that around the Johnson Space Center there is developing a number of small companies, managed and started by people that have left NASA.

The technology was developed there, the people had the know-how there, and they are not out starting private companies. Frequently it is not even a space related business, but it is taking the technology that was developed and the know-how that was developed and moving it into the private sector.

A new kind of Gamma camera for imaging nuclear medical diagnosis, for example, or a digital imaging work station that was originally used to enhance photographs from the moon. These products have value, and that is an area where we get fall-out locally.

There is just no question that with the kind of people that come out of the Johnson Space Center, as space commercialization moves into the private sector (and it is certainly bound to happen) this is a natural location for leadership in that area.

Senator **Bentsen**. Mr. Norton, you were commenting earlier about the sharing of the intellectual capacity that has developed at universities.

Thursday night I was able to get agreement in the appropriations bill that $10 million a year would be used for scholarships for space, and I was very happy to be able to get that in the program, because my concern is 20 years ago we had six times, at least six times as much in the way of scholarships and bringing young people in, educating them for the space program than we have now.

As I read about the Russians and what they are doing, they have a constant inflow of young scientists who are moving into that program. I think it is absolutely vital that we have that kind of an input, a continuing one, with the universities and those scholarships for those young people, to encourage them into the program.

Would you care to comment on that?

Mr. **Norton**. Absolutely. As one who has been teaching at Texas A&M for the last 16 years, which, incidentally, has the largest department of aerospace engineering in the United States, I have seen the enrollment, of course, vary considerably, but the support in terms of scholarships has virtually dwindled away.

We used to rely very heavily on NASA scholarships and NDEA scholarships, and many others. So I do believe that we are in danger of not having sufficient scholarships to keep attracting the brightest people into this field, and we need new thinking and new blood and the young people coming up through.

Senator **Bentsen**. I yield to my colleague, Senator Pressler, for any questions he has.

Senator **Pressler**. Thank you. I am very interested in that last remark, because I understand that over half of our graduate students in engineering in the United States are from foreign countries. Not that that is all bad, but the point is we do not seem to be taking full advantage of all of our educational opportunities, not only for the space program, but also, in medical research and in the hard sciences. Nevertheless this is a trend that warrants our careful and serious consideration.

I have a question for each of you, and you might take them together or individually. I will address the first one to Mr. Cunningham.

Mr. Cunningham, you have called for subsidies for shuttle launches to meet the competition of subsidized launches by the French Ariane system.

How will subsidized shuttle launches affect our domestic ELV industry, which has for a long time argued that shuttle subsidies were preventing it from competing in the world launch market, and how can we subsidize government launches and expect our domestic ELV industry to compete effectively?

Mr. CUNNINGHAM. That is the area of conflict that Mr. Frankle mentioned, or one of the areas of conflict, and it seems to me that we are trying to—our interest in this country should be that we have satellites launched in the most cost effective way.

Personally, if the most cost effective way would be for all of these vehicles to be launched by NASA, I would be in favor of it. That is not likely to be the case.

If the contractors, and there are at least three of them in this country operating now who have sold commercial launch services based on government developed launch vehicles, if they are not cost competitive, then they are not going to keep doing it. The incentive has got to be to make a profit.

The government is going to have to find a way, if we want them to supply launch services, to find a way to make some profit.

I would think that one of the ways of doing that is by not cutting off the procurement of expendable launch vehicles. It is obvious now, in retrospect, and should have been obvious at the time, that we do not want to put all of our launch eggs in one basket.

The government, by buying Atlas and Delta rockets, is certainly going to be able to reduce the cost of those vehicles.

Senator PRESSLER. Mr. Norton, according to your testimony, Congress should develop mechanisms by which the private sector can utilize government and university research.

What is preventing the private sector from utilizing the research now, in your opinion, and specifically what kind of mechanisms do you envision to leverage the research efforts of government and academia?

Mr. NORTON. The research question in the United States is a very complicated one, and it occurs in so many different places.

I think what I am trying to say is that, for example, a small new company does not really have its own research staff, and might not be able to initiate a $1 million research program, whereas some of the necessary talent may reside in government or in universities.

If there was a mechanism by which those research establishments could provide those capabilities to the small company at an early stage to sort out his ideas, I think it would be very valuable and is not something that is currently addressed.

If you want to be a member of a commercial center for development of space, you better have your $50,000 or $100,000 and you better AT&T, and then you can be a member of one of those teams.

Senator PRESSLER. Your answers are quite insightful, and I thank both witnesses.

Senator BENTSEN. Thank you very much, Senator Pressler.

Let me just ask one closing question here. How does the development of the commercial centers for the development of space at the University of Houston and Texas A&M enhance the potential for commercial space activities?

How does the business community perceive those centers?

I worked on those, and so I have a personal concern, and I want to get a reaction as to what you think can be done with them.

Mr. **Norton**. Well, I think they have been an excellent step in the sense of focusing on commercial development of space by bringing some of that excitement to the university community which really, does not normally get involved in, commercial activities.

So it has brought a new kind of excitement to both those universities, and caused them to deal with some important business issues.

I am a little concerned, as I mentioned earlier, that the access to that process is somewhat remote from the average company or from the space entrepreneur in that they are not able to reach into these centers effectively.

So that would be my one concern. Walter?

Mr. **Cunningham**. Senator, another aspect of business participation that benefits the universities, of course, is the industry partners. Each of those centers for the commercial development of space has required a significant participation by industry partners.

In many cases those are new industry partners for that particular university who become familiar with the areas of research and enable the university to have the interchange in the commercial sector.

I think that is a very important marriage that goes on in that area.

Senator **Bentsen**. When I look at what has happened, up in Massachusetts and New England for example, and the interaction which occurrs between the universities and the private sector and I look at their economic condition 10 years ago and how they have improved it dramatically, I see how important the cooperation is.

I look at our problems and our concerns here in Texas and I think we have a lesson to learn there, and I just think these centers could be of some help, and we have to strive to get the kind of interaction to diversily and create the jobs here.

Mr. **Norton**. Well, there is no question about it, and it has been very exciting. I think if you look at any of those regions that you have mentioned, you will see that they were able to leverage off of federal research dollars to begin the process.

It is the universities and it is the next step beyond the universities, the Lincoln Labs and the Stanford Research Institutes, which then carried on that big role of actually dealing with the private sector. Universities then can concentrate on basic research and education. There needs to be the intermediary groups which are so effective.

Mr. **Cunningham**. Here in Texas, Senator, we are 10th in the amount of federal research and development dollars received by the states.

Senator **Bentsen**. Well, I get a lot of dispute over the actual numbers. I have seen a number of studies as far as the return of federal dollars to Texas.

One of the recent ones that got a lot of publicity was limited, though, to only about 30 percent of the dollars being considered, and when you get to the full numbers, and I have seen some more current studies bringing that in, we do much better than that initial study showed it.

But there is no question but what we have to continue to fight to get more research dollars spent here, and that is what we are trying to do with some of these centers.

Gentlemen, thank you very much for your attendance.

Our next witnesses will be Mr. Wilton Scott, who is Chairman of the Board of Space Industries, Inc., Mr. James Calaway, Vice President of Space Industries, Inc., Mr. Bruce Ferguson, who is Senior Vice President of Orbital Sciences Corporation, and Mr. Donald K. Slayton, President of Space Services, Inc. of America, if you would come forward, please.

Gentlemen, before you start, let me tell you there is a very strong desire on the part of the subcommittee and the committee as a whole to make commercial space activities a reality for us.

However, to do that, we are going to have to be able to better understand your needs and see how we can relate to it in the way of legislation that might be helpful in trying to knock down such bureaucratic or legislative barriers as you can point out to us.

It is a pretty big concept and means a lot of different things to a lot of different people and to different Administrations. So I think one of our first challenges is try to determine our goals and define our terms.

At the outset, I would like to recognize your entrepreneurial capabilities and contribution that you are making.

Mr. Slayton, why don't you start us off and then we will proceed with Mr. Ferguson and Mr. Calaway and Mr. Scott.

STATEMENT OF DONALD K. SLAYTON, PRESIDENT, SPACE SERVICES, INC. OF AMERICA

Mr. **Slayton**. Senator Bentsen, it is a pleasure for us to be able to speak to you this morning on commercial space.

We actually have two areas of interest. One we have been pursuing the development and marketing of small launch vehicles since 1982.

Listening to some of your earlier witnesses, I thought maybe I should retire, but we are not quite ready to do that yet. We still think this is a viable business.

The second area we are dealing in is the Earth remote sensing. I only have a few comments on that.

I think you are generally familiar with our launch vehicles. I have some drawings in your handout and I will not dwell on those, but we have a model up here on the table and that represents our largest vehicle. [Fig. 1.]

We can put about 4,000 pounds into low earth orbit with that vehicle, and to put that into perspective, the shuttle can handle about ten of those kind of payloads.

We can also put a small 600-pound payload in to geosynchronous with that. Strip all the outer motors off and the core is our small vehicle, and that will put about four to five hundred pounds into LEO. [Fig. 2.]

The shuttle, again to get perspective, can handle about 100 of those kind of payloads.

So we are really targeted to the niche market. We do not view ourselves in competition with the shuttle. We are, we think, complementary to it, and that is our intent and has been since day one.

Our intent is to service the small user, and there are four major payloads that we have looked at, and we find in all of those there is a parallel interest between the commercial sector and the government. [Fig. 3.]

These are navigation, communications, earth remote sensing, and materials processing, which you mentioned earlier. We view this common interest as mutually beneficial with the private and the public sector sharing a development cost and both obtaining economies of volume operations.

I might add at this point that we have had interest—we were worrying earlier about the U.S. Government, or people going outside the United States—from four European countries and one Asian applying our vehicle to satisfy their needs, because they think we can do it better than they can in their own countries.

We have communicated with every element of the U.S. Government that we have identified that has a spacecraft under consideration within our performance range, and we find a lot of interest but as of this date we have not had a contract with any element of the U.S. Government.

There are a number of reasons for that. A number of these are under discussion but not yet approved. There is another category that are in development phase but do not yet need to commit to launch services.

The third one is a group that we think is approaching a state of desperation. They were anticipating basically a free ride or a subsidized ride as a secondary shuttle payload, and with the realities of secondary payload manifesting, setting in, it is becoming obvious that many of these small payloads will never get on the shuttle.

There is also no funding in anybody's budgets that we know of to procure a non-shuttle launch service for the small vehicles. This is understandable because, as you have heard this morning, there are still a lot of problems related to handling the large primary payloads, and the small ones have just not been addressed at this point.

The other problem is that the costs of providing a dedicated ELV for a small payload is an astronomical increase over the relatively cheap costs of doing it on the shuttle.

The ratio of launch costs to program costs is generally much higher with a small, cheap satellite than with large, expensive ones.

If you can launch on the shuttle for $10,000, we probably are 20 times higher than that to get the same equivalent small payload up, just to put things into perspective.

We are continually searching for ways to decrease the costs of transportation to the small user, and we accomplish part of this by using well proven, highly reliable components where they are available.

Unfortunately, we believe that the potential for big cost savings from any technical improvement in chemical rocket systems, is relatively small. The cost of motors is only 20 percent of the total cost of a launch.

We think the real potential for cost savings will come from a change in the way of doing business, and that is what we are selling.

It is a major frustration to us in many briefings to potential government customers that somebody in the audience insists on knowing what our plan is for replacing the function of the government employee in our commercial approach.

It is not a popular response to indicate that we do not view that function as cost effective or an additive to our reliability factor, but that is the real commercial world.

In conclusion, I am proposing that an appropriate and cost effective way for the government to procure future unmanned, and I underline unmanned, launch services is not to buy hardware but to buy turnkey launch services.

That is underway at the present time with the large vehicles. We anticipate that that will be the case with the smaller one as we go along.

There is only one area that we think needs to be addressed from a legislative point of view, and that is the liability insurability issue.

We at the present time not only have to insure against the actions of our own employees but we have to insure against the actions of government employees and government contractors on site that we have absolutely no control over.

The above comments apply equally to the big and to the small vehicles.

Additionally, we feel that the maximum liability insurance requirements placed on a large vehicle at Cape Kennedy versus a small vehicle at Wallops Island, where we are currently planning to launch from, should be significantly different.

If we launched a Conestoga out of Wallops and had a multiple, independently targeted warhead on it, returned it to launch site and destroyed everything there, it would not be within $400,000,000 of what we are asked to insure against. So we think the perspectives are off a little bit there.

That spread is not as dramatic, obviously, on the large launchers, but even there, with a range safety system working as advertised, the risk factor is really close to zero.

Another way to put this in perspective is to ask whether in the 30 years of space operations a liability claim due to launch failure has ever been honored, and our information indicates the answer is no to that.

Shifting gears to the earth remote sensing, we submitted a proposal in response to the 1983 RFP aimed at selecting a commercial follow-on to LANDSAT. We were one of the three companies that were qualified but were eliminated primarily because of our small company start-up status.

We bid a system that we had developed earlier as a commercial system. Bringing that system into compliance with the government's requirements increased our costs by a factor of three without appreciably increasing the capability, at least in the space segment.

Three years later, as Senator Pressler has noted, the last operational Landsat has exceeded its design life by about 25 percent, $90 million has been spent on a follow-on system, and we are still $260 million, excluding launch costs, short of, and at least 2 years away from, launching a system contracted for in 1984.

We believe the government does have cost effective alternatives. Someone—our company, and there are others—could put up, we believe, a suitable satellite for the money programmed in 1987. [Fig. 4.]

We could put up another one for the money that is requested in fiscal 1988. The government would save $140 million plus $110 million in launch costs by following this path. You would obviously have to write off the $90 million that has already been expended.

These numbers do not include also the $30 million annual operating costs per year of the existing system.

Another alternative would be to make no further capital investment, allow the private sector to capitalize a system which they cannot and will not do in competition with a government capitalized system.

Under this scenario, the government must guarantee a minimum annual data buy and ground station operating expense equal to the current costs. Our projections are for increased government requirements for data and decreased ground station costs.

The real cost to the government comes out approximately the same under either scenario and the choice is about as simple as paying in advance versus buying on the installment plan, but we think there are viable alternatives.

Thank you for the opportunity, and we will stand by for questions.

[The attachments referred to follow:]

Figure 1

Conestoga Vehicle Evolution

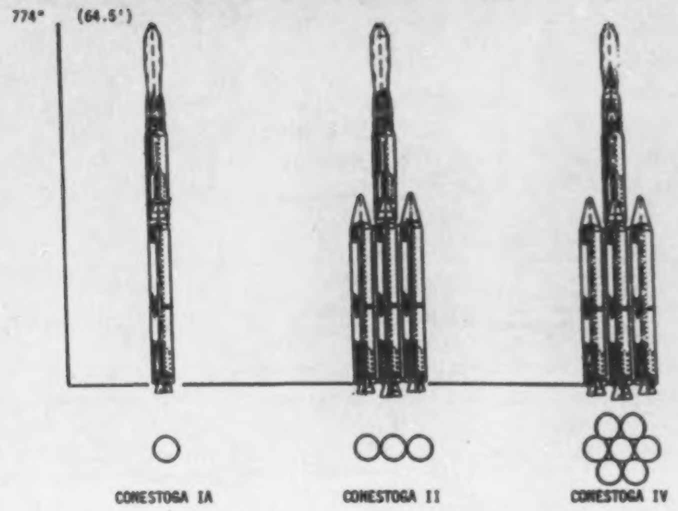


Figure 2

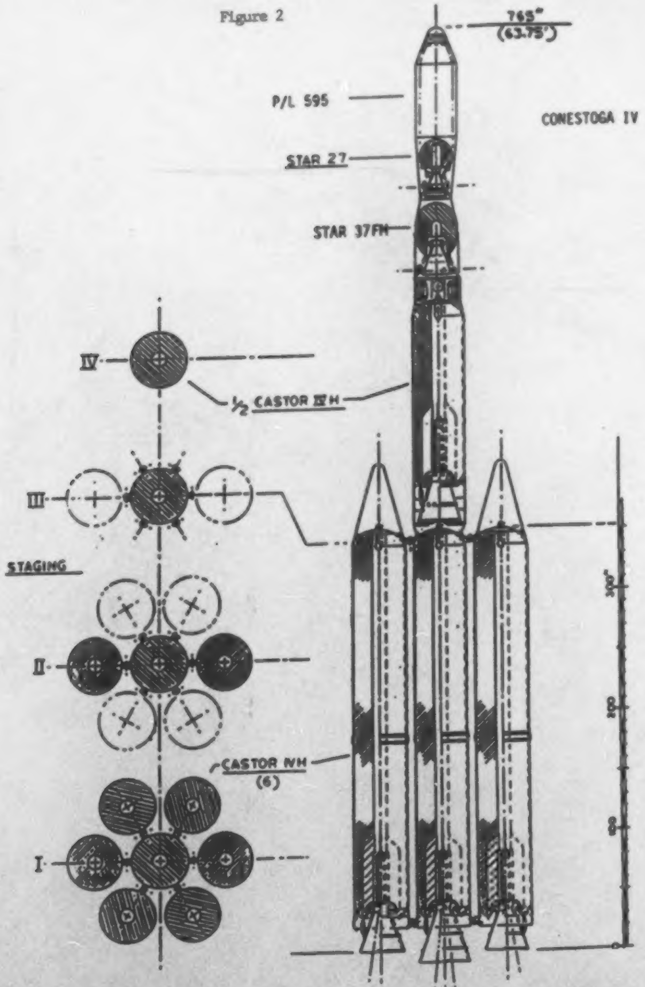


Figure 3

SMALL SATELLITE SYSTEMS

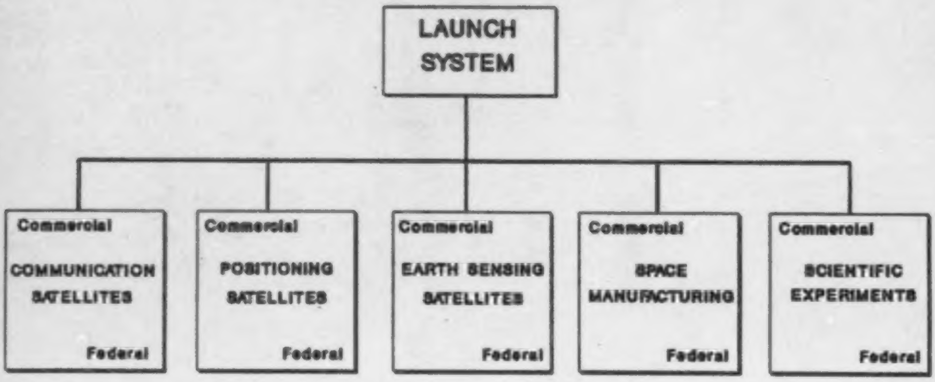
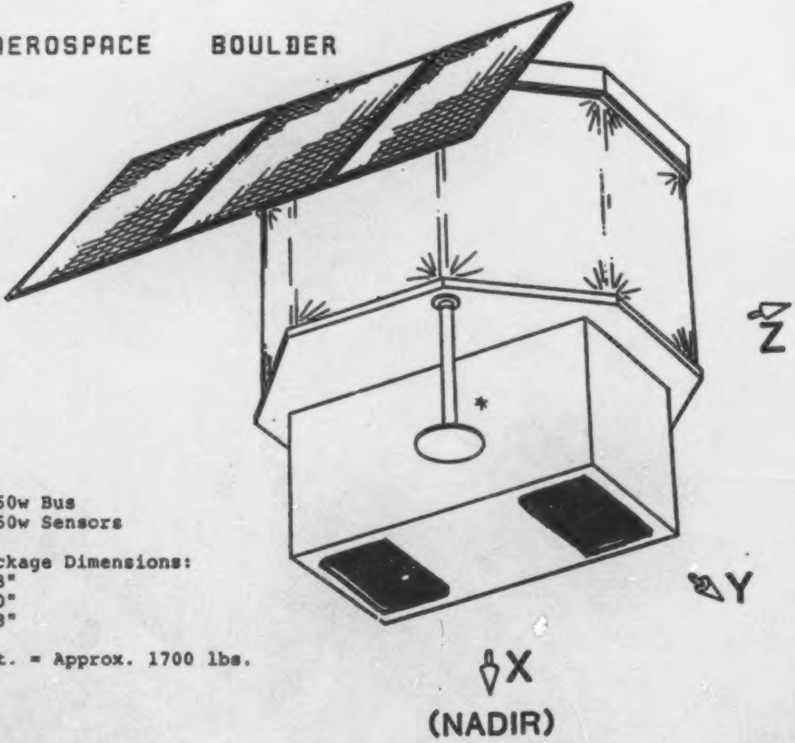


Figure 4

BALL AEROSPACE BOULDER



Power: 160w Bus
250w Sensors

Sensor Package Dimensions:
h = 43"
l = 80"
w = 38"

S/C bus wt. = Approx. 1700 lbs.

Senator **Bentsen**. Good.
Mr. Ferguson.

STATEMENT OF BRUCE W. FERGUSON, SENIOR VICE PRESIDENT/FINANCE AND GENERAL COUNSEL, ORBITAL SCIENCES CORP.

Mr. **Ferguson**. Thank you, Mr. Chairman, and Senator Pressler. It is a pleasure to be here today.

OSC, Orbital Sciences Corporation, has had a long relationship with Houston over the years. We first received a grant from the Space Foundation four years ago that got the company started.

We received our first seed capital investment from a group of Houston investors. A number of investors in our large research and development limited partnership, which raised $50 million, are located in the Houston area, and I have the pleasure to announce that last month OSC, which is based in Virginia, opened an office in Houston to manage its continuing relationship with Johnson Space Center.

I feel that OSC and the government to this point have had a very productive partnership and would like to discuss that a little bit.

We raised the financing and provided the technical personnel for this partnership to develop our first product, the transfer orbit stage, which takes satellites from the low earth orbit of the space shuttle into higher orbits. NASA, for its part, provided technical oversight, using its vast experience in the space area.

After successful completion of development last year, we competed in a regular government procurement and won. This year we should have revenues of $20 million and expect to launch in 1991 the first of two missions, the Advanced Communications Technology Satellite and in 1992 the Mars Observer probe, our nation's only Mars initiative planned through the end of this century.

Because we have achieved what we have, I can tell you that commercializing space is a very difficult proposition. I feel that a lot of the bad press that the government has received recently, and particularly NASA, is a bum rap.

The government has done largely what it can do to help commercial space. There are two factors, I think, that are largely overlooked in evaluating its record.

First, new companies in this country have a very high mortality rate. Something like nine out of ten fail in the first year or two, regardless of industry.

In this industry in particular, which is characterized by very high capital requirements, very long pay-back periods, few markets, if any, beyond the government, except perhaps in the commercial satellite area, and all the environmental risks that have been described earlier, it is not surprising that many space companies are having difficulty. Even we ourselves are not out of the woods yet.

The second factor I think is often overlooked in evaluating NASA's record is the fact that there are very important goals that our country has in space apart from commercialization.

Our military goals are often talked about, but it is as though they were in a different world from the launch facilities that we have available, the resources that the government can provide, For space commercialization .

It is also I think not often enough recognized that NASA has very important mission goals of its own that it must implement. It is charged with making sure our country stays ahead in the exploration of space, and in meeting long-term goals that are important to our country.

Mr. Frankle mentioned earlier that space companies themselves may have different goals that conflict, and that policies designed to help one segment may hurt another.

Finally, as you yourself noted, Mr. Chairman, on this "morning after" of the Sputnik launch 30 years back, other countries have key goals in space that they regard as very important, that make it difficult for our industries to compete. It can be argued that remote sensing, for example, is now largely dominated by European interests, just as it could be argued that commercial launching is now a European preserve.

All that leads me to three recommendations. First, I think it's important for the government, in this process of evaluating policies and goals, to recognize that there are conflicting goals and that government needs to set priorities. It is futile to promulgate new policies on commercial space if the agencies charged with implementing them cannot, because implementing them would somehow conflict with their own basic mission and agency goals.

Second, I think it's very important, as has been mentioned earlier, that the government ensure that there is access to space. Otherwise, it's very difficult to commercialize that which we cannot reach.

There are a variety of ways of approaching this. I agree it is a very complicated area, but at present I must say that our own firm is in an unacceptable position. We invested tens of millions of dollars in a shuttle based technology which was designed to have commercial customers as well as government customers. Now we find, as a result of the decisions that have been made in the past, that we cannot fly in the shuttle, nor, on the other hand, are we entirely comfortable that there will be a commercial launch vehicle industry in this country without further government support.

So it seems to me the government has to step up this priority, if it is going to be a priority. If there is going to be commercialization of space, it's going to be costly and the government has to help provide the basic resources we need.

Finally, I would recommend that because the government accounts for more than 90 percent of all purchases of space goods and services, that the government use its procurement authority as a very powerful tool in implementing the commercialization of space. There are legal and other obstacles to use of that authority, but is such an important area with such promise that I feel it must be studied more carefully.

I would like to draw the analogy between the commercialization of space and the Olympic Games. Space commercialization is to business, I feel, what the Olympic Games are to athletics. National prestige rides on every event, and government support for competitors is a fact, whether or not we accept it.

There are going to be many challenges ahead of us, and I think it is going to be very expensive to meet those challenges, but I feel that if government can chart a true course, and hold to it, that American industry can set sail with the best of them.

Thank you.

[The statement follows:]

STATEMENT OF

BRUCE W. FERGUSON
SENIOR VICE PRESIDENT/FINANCE AND GENERAL COUNSEL
ORBITAL SCIENCES CORPORATION

Mr. Chairman and Members of the Subcommittee:

In the two and one half years since I last appeared before this Subcommittee, the landscape of the commercialization of space has changed almost beyond recognition. In the wake of the Challenger accident, the time is past due for a review of our nation's space policies -- including our policies regarding the commercial utilization of space -- as thorough and searching as the exhaustive technical and programmatic review that the National Aeronautics and Space Administration (NASA) and the Department of Defense have undertaken of their launch systems. For the policy risks we face are similar in degree to the technical and programmatic risks faced in each launch: there is little room to maneuver, and little margin for error. Notwithstanding the risks, however, the importance of space commercialization means that there can be no question of whether to proceed -- only of how best to proceed. The attention that the Subcommittee is paying to this topic is thus both timely and important.

Introduction to Orbital Sciences Corporation (OSC)

OSC is a small company headquartered in Fairfax, Virginia. Our first product, the Transfer Orbit Stage (TOS®), is a privately-financed space transfer vehicle designed to carry payloads from the Space Shuttle into higher orbits or on planetary missions. Financing has been substantial, consisting in part of a $50 million investment by private investors in one of the largest research and development limited partnerships completed in this country. Our TOS vehicle has been integrated on the Space Shuttle, and with the expenditure of additional integration funds could also be used on the Titan launch vehicle. The TOS development program is substantially complete; a production program is now underway to manufacture two operational TOS vehicles for NASA to be used on the Mars Observer and Advanced Communications Technology Satellite (ACTS) missions. This year, on the basis of this first contract, OSC's revenues should exceed $20 million. OSC's ability to exploit fully the potential of the TOS system has been significantly constrained by the fact that the Space Shuttle is no longer available for commercial satellite payloads that might use the TOS vehicle. With the recent expansion of our facilities and staff, we are now embarked on active development of a second space product which we hope to announce within the next few months.

The Sources of Today's Challenge

In analyzing how to remove obstacles to space commercialization, I believe that it is especially important to understand what the "commercialization of space" must entail. For we are not talking about an industry -- computers, biotechnology, even sectors as broad as communications or data processing -- but instead about a place. Think how difficult it would have been 500 years ago to plan for the "commercialization" of the New World! Or today, how many complexities immediately spring to mind should we discuss the commercialization of the seas.

On this last point, what would I say today were this hearing held on commercialization of the oceans, rather than space? I would begin by noting the enormity of the challenge -- that it has taken all of man's history to commercialize a relatively small fraction of the land, whereas water covers most of the Earth's surface. The scale of the challenge is compounded by our unfamiliarity with living and working on and in the oceans for long periods of time. Second, I would observe that the oceans differ radically depending on one's location -- some parts of the ocean are shallow, some deep; some of the oceans are very salty, some are fresh; some are warm, some are covered with ice; some are close to shore and easily accessible, some are very difficult reach. For technical and economic reasons, this diversity determines the uses that may be made of the ocean. Third, I would note that there are an enormous number of military, civil government, and commercial uses for the ocean, and that especially within the commercial sector there are innumerable private activities that are being conducted or could be conducted with the proper incentives. Private activities include transportation -- hauling freight, transporting people -- recreation, mining, food production, and waste disposal. And, because there are so many uses of the ocean, in many areas the goals of those who seek to use the oceans conflict -- the fishing industry may object when offshore drilling for oil is proposed, for example, or the owners of beachfront property may demand protection against oil spills from tankers. Finally, countries other than the United States also have vital interests in the oceans. These are the characteristics I would note were this hearing to deal with the commercialization of a relatively untouched part of our own planet.

Instead, we are here today to discuss an even more difficult proposition. Fortunately, I can use many of the same arguments I had prepared for ocean commercialization. We as a nation propose to explore and develop a place that dwarfs anything we can imagine based on our everyday experiences on this planet. Routine access to this place is beyond the financial means of nearly everyone save a few governments and corporations. It is not homogeneous: some parts are more accessible even than parts of the ocean, while some are completely unattainable at present. In a word, some parts are more valuable. One particularly desirable part of space, of course, is geosynchronous orbit, the most valuable real estate in the solar system -- with the possible exception of downtown Tokyo. There are a variety of uses of this place that already exist, including military, civil, and commercial. These interests can and do sometimes have conflicting goals and needs. And, as with the oceans, Houston plays a major role, which is why our firm last month opened an office in this city. The office marks OSC's continuing commitment in our five-year relationship with Johnson Space Center, Houston's investment community, and the Space Foundation.

As with the oceans, of all that it is possible to do in space, commercial activity is necessarily limited to a subset. The economic and technological constraints that help define this subset are apparent -- it is just not economically feasible at present to mine the moons of Jupiter or to collect hydrogen from the solar corona, any more than to establish a commerical fishery at the bottom of the Mariana Trench. Less apparent, perhaps, but just as important are the constraints posed by competing interests in space, which further narrow the subset of feasible commercial activity, further restrict the room to maneuver. Let me analyze this statement, starting with military interests.

Our first priority in space, as it is on land and sea, must be to preserve our national security -- and it is the same for many other nations. Thus, for example, national security payloads must have precedence when launch capacity is allocated. To meet future military needs, new launch systems are planned to reduce launch costs by a factor of ten -- systems that might compete with commercial systems. Certain radio frequencies can be used only for military purposes. Strict technology transfer controls limit companies' ability to market advanced products to foreign customers. Even marketing to U.S. customers may be prohibited if a technology is classified. Finally, the resolution of commercial Earth remote imaging is restricted. The better the pictures of the Earth and its resources provided to commercial users, the more nervous our military planners become about their ability to conceal military actions from those with potentially hostile intent. While industry may chafe against these restrictions, our armed services are sworn to defend this country, and it is difficult to find fault with constraints that properly flow from such a strongly shared goal.

It is not often enough recognized, however, that NASA has its own mission to fulfill, and that constraints flow from this mission just as they do in the military arena. Two years ago proposals were submitted to privatize the Shuttle system, whereby private companies would operate the Shuttle fleet and provide launch services to NASA on a commercial basis. Similarly, NASA today faces a broad range of proposals to commercialize vital space station functions and other functions very important to the agency. So where do the constraints enter in? I believe that there is a more powerful answer than the commonly-heard suggestion that NASA merely acts to protect its prerogatives. In fulfilling its mission -- operating a Shuttle fleet, developing the space station, exploring the planets, or more broadly, developing the potential of space -- NASA is held to a very high standard of performance. The Space Shuttle has demonstrated a reliability of 24 out of 25 -- 96% -- which no one would agree is good enough, and for which NASA has been severely criticized. On the other hand, new businesses in this country typically have a failure rate of up to 90% in the first two years. It is difficult to pick projects and companies that will succeed -- Wall Street has been trying to do this for years, with mixed results -- and it is hardly fair to hold NASA to a higher standard in this area than the experts. This being the case, how is it possible for NASA to assign technology elements vital to the success of its mission to the private sector? How can it achieve its 96+% reliability by giving up development and control of key components to enterprises that may have only a 10% chance of surviving until the next Congressional election? Regarding those proposals to commercialize the Space Shuttle, would our nation's space effort be in better shape today if it were a private firm, rather than NASA, that was responsible for funding and fixing the Space Shuttle system in Challenger's wake? I believe that at the heart of this dilemma is a fundamental mismatch in the acceptability of risk: a failure rate that is acceptable in the private sector may be intolerably high to public officials charged with the responsibility of protecting and advancing our nation's welfare in space.

The high mortality rate for new commercial projects could perhaps be reduced were the Government to provide direct financial assistance to companies, as through subsidies. Such direct forms of Government support for private enterprise, however, violate other constraints within the political system. It is necessary to approach the problem from another route. Rather than attempting to find ways to spin off essential parts of key Government programs to the private sector, for example, we must encourage commercial development of technologies or products that are useful, but not essential, to NASA or the military in fulfilling their missions. This concept of assisting, rather than competing with, agencies of the Government in their missions is a vital one if private enterprise is to find a niche in an area so dominated by vital Government interests. So long as the proper projects are targeted by private industry, the Government can logically be expected to provide support through its purchasing power and through other forms of indirect support.

On this point, there is in this country a voluminous body of procurement law that severely constrains the Government's ability to innovate when it comes to the ability to promote or encourage commercial development of space. To some extent this law may be responsible for the Government's slowness in implementing many of the existing policies supporting the commercialization of space, such as the President's National Policy on the Commercial Use of Space, which encourages the purchase of commercial hardware and services under appropriate circumstances. We believe that there are ways that existing acquisition regulations could be utilized or modified so as to encourage new commercial space businesses. For example, directed source procurement exceptions would be applied, and selection criteria modified as necessary. Maximum periods of evaluation and contract award for procurements could be established so as to minimize the burden on new competitors. Similarly, recovery of bid and proposal expenses by new space businesses could be permitted. Finally, an "announcement of opportunity" could be used when practical instead of formal requests for proposals, again to minimize costs.

In addition to the constraints posed by military and civil objectives in space, constraints are created by the conflicting goals held by space businesses themselves. For this reason, a policy designed to help one industry may actually hurt another. This has certainly been the case for two key space industries: commercial satellites and commercial launch vehicles. On its face, the Administration's decision not to honor NASA's launch contracts with many commercial satellite owners, while helping the infant commercial launch industry by eliminating Government competition, hurt the owners of these commercial satellites. The decision also represented a blow to upper stage manufacturers such as OSC who had invested heavily in Shuttle-based technology, only to have the commercial market for their product eliminated by decree. At another level of analysis, the actual injury may not have been as substantial as it appears because of the near-term dearth of capacity on the Space Shuttle and the fact that national security payloads were to receive priority for the capacity that did exist. This example illustrates that, while we may all agree that commercialization of space is a desirable objective, we may disagree as to how to achieve that objective, even on such basic issues as the right of key commercial space segments to use our nation's primary space transportation system for access to space.

Other countries' space goals also circumscribe the realm of feasible commercial activity. The strategic importance of the launch industry means that commercial suppliers face an increasing onslaught of government-supported launch systems. Japan, China, Brazil and India -- even the Soviet Union -- have all announced expendable launch vehicle programs that will intensify the fierce competition already provided by Arianespace for commercial payloads. Similarly, European efforts to develop the promise of materials processing in space pose a daunting challenge to any private company faced with shouldering substantial research and development costs. Foreign suppliers may in fact already provide the best remote sensing services commercially available. Space is important to all powerful countries, not just our own. We have all read the same histories, all heard the same analogies, all recognized the same potential of space. Other countries are just as determined as we not to be left at the starting gate. Space commercialization may thus be regarded as the business equivalent of the Olympic Games: national prestige rides on every event, and government support of competitors is a fact, whether we sanction it or not.

Results to Date in Meeting These Challenges

These are some of the major constraints to commercialization of space posed by other legitimate interests. How have commercial space companies fared in the face of these constraints? By our count, there have been 48 commercial space activities in the 1980s that have gone beyond the proposal stage. They offered products and services ranging from space transportation to innovative commercial communications satellite services, from remote sensing to materials processing and facility provision. Several of these were international enterprises. Of these 48, only 6 or 7 can be counted as anything other than failures today. Thus, within the range of definitional and statistical error, our experience in commercializing space seems to track the average record in the United States across all industries.

Some will find this accounting to be discouraging. After all, if we are accustomed to think in terms of 99% reliability, this sort of industry performance is scarcely one to inspire investor confidence. On the other hand, I would find in it some bright rays of hope. There have been companies that have survived, and they have survived despite intrinsic barriers that make the commercialization of space one of the most challenging business prospects in the world, barriers that include high capital requirements, long payback periods, limited markets outside the "command economy" of Government purchasing, and the existence of all the conflicting interests that I described earlier.

It is unfair to criticize the Government unduly for the failures that have occurred. As President Kennedy once observed, "Success has a thousand fathers, but failure is an orphan," although I would add that failure may lead to numerous paternity suits. As I survey the list of firms that, for one reason or another, have not been able to succeed in their commercial space activities, I would ascribe a range of reasons in addition to the obstacles that exist in our regulatory, legal or policy framework, reasons that include lack of adequate financing, lack of a market -- particularly important if the proposal will in some way conflict with the mission of a Government agency -- lack of experienced management, and lack of adequate technical or program expertise. And, of course, a problem that we all have right now: lack of access to space to commercialize.

While it may be unfair to lay the blame for these failures at the Government's door, it cannot be said either that the Government has done a good job of supporting commercial space enterprises. By "support" I do not mean subsidy -- I speak of implementation of existing policies promulgated by the Administration, NASA, the Department of Transportation, and the Department of Defense, that would help commercial space companies. For example, of the twelve policy initiatives announced by the Administation three years ago, only one agency -- NASA -- has made meaningful progress in their implementation. However, even NASA's progress has been slow, with one initiative completely implemented, six in process, and five not implemented at all. Even more serious than the slow implementation of policy, however, has been a complete lack of consistency and stability in policy which all but eliminates the ability of private companies to plan reasonable business programs. In the past thirty years, there have been thirty-six major changes in five key areas of national space policy affecting commercial ventures: launch vehicles, satellite communications research and development, mobile satellite communications, aeronautical satellite communications, and remote sensing. I am certain that the conflicting interests I described earlier are in large part responsible for this kaleidoscope effect in national space policy.

Whatever the reason, it is clear that the agencies have been slow to implement many stated policies that would assist the commercialization of space. Perhaps the policies go too far, perhaps the agencies can't or won't go far enough, or perhaps the expectations of commercial space companies are too high. It is difficult to identify a general cause that explains all the observed results -- the experience of each company and agency depends on particular facts and circumstances that appear to be dispositive. I am happy to note that in OSC's case, NASA has indeed implemented the policy of purchasing commercial space hardware when practicable -- albeit after a formal competition and procurement process that lasted more than two years and cost OSC and its suppliers hundreds of thousands of dollars.

Some Predictions

As I have said before, the existing constraints provide little room to maneuver. In fact, apart from three areas, for the foreseeable future space will remain what it is today: a devilishly difficult place for a private company to make a profit.

What are these three exceptions? The first is perhaps more customer-oriented than industry-oriented -- Government contracting. Because the Government accounts for more than 90% of the total U.S. market for space hardware and services, it is a very difficult market for any company to ignore. The dominance of the Government as a purchaser has in effect created a "command economy" in which "the customer is always right, sir." Because of our nation's legitimate goals in the military and the civil Government sectors, it is not likely that this fact of life will soon change. Nor is it without its advantages -- the business base provided by Government purchases may be essential in reducing costs or providing technology necessary to successful commercialization. This is certainly true in the history of commercial jet transportation -- the Dash 80, the prototype of Boeing's 707, was based on Boeing's experience in designing military aircraft. The McDonnell Douglas Payload Assist Module upper stage was developed with private funds that supplemented substantial Government investment on the Delta launch vehicle. Government development of the Inertial Upper Stage similarly provided a technological base for OSC's development of the TOS vehicle. Therefore, while Government contracting may not itself meet a test of "true" commercial space activity because of the lack of commercial markets, it nonetheless represents a business opportunity that may provide resources essential to future commercialization efforts.

The second area where companies have just barely been able to make profits, at least historically, has been the sale of commercial communications satellite hardware. The United States has several good examples of firms which have made major investments of their own funds to develop an international lead in technology that has enabled them to serve one of the few non-Government markets for space services that currently exists. While external factors such as the rise in fiber optic services and the hiatus in the West's launch capability have severely threatened this industry, it still has been an area in which profits could be made. In fact, were we to look only at revenues, it is hard to refute the conclusion that for most of the Space Age commercial space activity has consisted of commercial communications satellites -- and little else.

A third area that may emerge as a strong commercial space industry is the launch industry. Today the dominant supplier is Arianespace, which with a successful launch on September 15 tentatively renewed access to space for Western commercial payloads. While significant progress has also been made by a few domestic companies in marketing private launch services, I believe that it is too early to tell what the long-term success of these efforts will be. Because OSC and other upper stage companies are no longer permitted to launch commercial satellites from the Space Shuttle, we have a strong incentive to see domestic launch vehicles such as the Titan, Atlas, and Delta succeed in their quest to provide a viable alternative to foreign launch vehicles. Nevertheless, an honest appraisal of these efforts must conclude that there is still substantial business risk, given the willingness of foreign governments to subsidize or otherwise support their own launch capabilities for reasons of national prestige or national security, the technical and financial risks associated with launch of these vehicles, and the high capital investment required for operation, modification and, especially, upgraded performance.

When it comes to new products and services, large companies are not exempt from the high failure rate I described earlier. Our domestic launch vehicle industry needs additional support from the Government if this experiment is to succeed. Otherwise, the awkward spectacle of a free trade country banning use of Soviet (but not Chinese) launch vehicles by U.S. payloads will continue indefinitely.

Conclusions and Recommendations

My major conclusion I have stated already: there is little room to maneuver among the maze of constraints that exist, most if not all of them for very good reasons. A second conclusion is that there is no inexpensive way for our country to greatly accelerate the rate of commercial space activity. That it is desirable, we all should acknowledge -- a strong industrial base is vital even to our military capabilities. It will, however, require enormous investment by both the Government and the private sector for new space activities to succeed -- a message that Mr. Roy Gibson, former head of the British space agency, resigned in order to convey to Prime Minister Thatcher. And third, each policy or change must be carefully examined to ascertain its effect on the wide variety of industries and companies involved in the commercialization of space, for it is probable that in the attempt to help one group, another group will be injured. While it is necessary to make such tradeoffs, we should try to minimize the costs.

Others must make recommendations in their particular fields, but I have three that would benefit the upper stage industry and perhaps other industries as well.

First, the Government must once again attempt to lay out clearly its stated policy goals in each of the key areas of space. Equally important, the Government must attempt to assure that its goals are internally consistent. It is futile to promulgate policies supporting the commercialization of space when more powerful countervailing goals in the military and civil areas necessarily mean that Government agencies cannot implement such policies. Establishing consistent goals is, of course, easier said than done -- and it will be expensive to do -- but unless this is achieved, commercial space efforts will struggle against enormous odds. Unless and until consistent goals are established, it is unlikely that substantial investment will be made by the private sector in new commercial space activities such as those relating to the space station.

Second, the Government must act swiftly to support its launch industry. Access to space is one of the key requirements for commercialization efforts, and is a requirement that is difficult to meet with private resources alone. In a worse case outcome, five years from now the Space Shuttle would continue to be barred for commercial satellite use and domestic launch vehicles would not have achieved the business base necessary to sustain operations. United States commercial payloads would then be flying exclusively on foreign launch vehicles, to the extent they flew at all. It is vital, therefore, that the Government have a plan to ensure access to space for commercial customers -- either to make the Space Shuttle available once again for commercial use should capacity become available as military missions are reassigned to expendable launch vehicles, or through direct Government procurement of expendable launch vehicles for commercial missions, or both. Otherwise, the growth of the commercial launch industry will proceed, but without substantial U.S. participation.

Third, the Government should examine ways of encouraging its contractors to invest additional money in research and development efforts geared to commercial uses of space. At present, many Department of Defense contractors are being urged to invest more money in Government competitions and programs. It seems to me that while the emphasis on contractor investment is sound, this investment should not be encouraged in Government programs. The Government, as any other customer, should pay a fair price for its goods and services and should not be subsidized, any more than private industry should be subsidized. Instead, contractor investment should be encouraged in commercial spin-offs likely to provide economic benefit to this country. I would propose to do this by expanding a program currently in place, called the Internal Research and Development (IR&D) account. At present, Government contractors may be reimbursed for a portion of any money they spend on research and development, so long as it is generally related to the goals of the Government. Oftentimes, this investment is required to be directed to particular near-term Government programs or goals. This element is a part of the general and administrative costs allowed to be applied against Government contracts. I would propose that the Government increase the amount of IR&D that contractors are permitted to be reimbursed by the Government, but only to the extent that contractors are able to reduce other general and administrative costs, so that net costs to the Government remain the same. Concomitantly, I would propose that the Government explicitly expand the permissible goals of IR&D work to include the development of commercial space products. Because the Government will remain the largest customer for a long time to come, it is likely that aerospace IR&D will always have a certain tendency to gravitate towards the Government's near-term program desires. Yet it is perhaps possible to increase the latitude of the concept in a way that costs the Government little while encouraging more application-oriented research and development as well as greater efficiency in general and administrative costs.

We have little room to maneuver. What maneuvering is possible will be costly. There is choppy water ahead, but if Government will chart a true course -- and hold to it -- United States industry can set sail with the best of them.

Senator BENTSEN. Thank you very much.

Mr. Calaway.

Mr. CALAWAY. Senator Bentsen, I would like to defer, if I could, to Mr. Scott for the prepared statements, but I will be available for questions.

Senator BENTSEN. All right. Fine.

Mr. Scott.

STATEMENT OF WILTON E. SCOTT, CHAIRMAN OF THE BOARD AND DIRECTOR, SPACE INDUSTRIES, INC.

Mr. SCOTT. Thank you. I am here as Chairman of the Board of Space Industries, Inc., and James Calaway here is our Vice President in charge of our Washington office.

Mr. Chairman, Space Industries, Inc., is in the business of operating space facilities and providing services to industry and government research and development organizations, seeking a further understanding of the advantages and benefits of working in the space environment.

Our first major product is known as the ISF, which is exhibited here. It will be the first permanent, man-tended commercial space facility designed for the research and development, testing, and eventually, processing in the space environment. It is simply a sophisticated space laboratory.

Our company approach is quite different from that of the traditional aerospace company. The primary difference is that we have financed our development program from high-risk private equity, and will continue to develop and construct the ISF program with private dollars.

In fact, we believe that the focus, efficiency and cost effectiveness of the ISF program are due in large part to this private sector approach, as well as to the extraordinary Space Industries team, with the eminent engineer, Dr. Maxime Faget, past Director of Engineering and Development at the Johnson Space Center, leading a team from America's leaders in the design, development and operations of manned spacecraft.

The space industries effort has grown substantially since our founding in 1982. We began with a few creative engineers. Today we lead an industrial team comprised of Westinghouse, Boeing and Lockheed.

Westinghouse is our primary partner and a major source of our financial and engineering support. Boeing has just recently joined the Space Industries partnership and will develop the docking system and equipment racks for the ISF program.

Lockheed has been under contract for over 2 years as the developer of the solar arrays which will generate power for the ISF. In all, there are over 120 engineers currently working on the ISF program.

We believe our industrial space facility will strongly support this nation's effort in space. First, the ISF will represent the first commercial development of important space based infrastructure.

Second, the ISF will be on orbit by 1991 or 1992 with our facilities representing an incremental, operationally compatible solution to the future users of the space station.

In this regard, we are receiving sufficient, significant support from NASA in working toward these objectives.

However, despite the impressive progress, our company faces formidable barriers to success. The foremost barrier for companies such as Space Industries is being able to raise adequate capital, given the uncertainties associated with this frontier environment.

In particular, those projects like the ISF which require presence of man, even if only occasionally, are currently inextricably linked to the shuttle. That linkage is extremely problematic from a financial perspective.

Bluntly speaking, the government's monopoly in providing manned access to space injects enormous uncertainties into the ability of prudent business executives to reliably plan space based endeavors on sound business principles.

That uncertainty, interestingly, is not solely a NASA problem, but is driven rather by the nature of the shuttle system itself.

Shuttle is a precious national asset with several priorities and objectives. Only one of these objectives is to encourage commercial space development. Therefore, commercial concerns are always subject to changing government manifesting priorities.

Unfortunately, from a financial perspective, launch contracts are not terribly helpful in relieving this uncertainty. The government has clearly demonstrated its willingness and ability to unilaterally abrogate launch agreements with little remuneration to those impacted.

We do not see the launch risk being eliminated, though we do believe NASA is diligently working to minimize manifest uncertainty.

When one adds to the shuttle uncertainty the fact that the insurance community is unable to even consider firm insurance underwriting, even assuming capacity and appropriate rates are available, until very close to launch, rather than 3 or 4 years prior to launch, when such insurance is needed to attract commercial debt for construction financing, the result is clear, private debt capital is not available for early commercial space infrastructure.

As a result, the commercial space developers have three options. They can, one, obtain government user contracts that address the limitations on the current fiscal and procurement laws, and that allocate risks, such as shuttle access and delays, so that the private capital markets are able to project finance the user agreements, or they can attempt to finance the entire program using solely private equity, or find a way to share the financial risk with the government by obtaining guarantees for the critical debt component of the total capital requirement.

Senator **Bentsen**. Mr. Scott, if you could summarize your statement.

Mr. **Scott**. Yes, sir.

Those three possibilities are in the first and second act really not available and we advocate strongly some type of government guaranteed loan for this industry.

[The balance of the statement follows:]

STATEMENT OF WILTON E. SCOTT, CHAIRMAN OF THE BOARD AND DIRECTOR, SPACE INDUSTRIES, INC.

Although the project finance option is possible, it would be very difficult to achieve. It would require either obtaining take or pay contracts where the Government-driven risk is borne by the Government or, in the alternative, receiving a non-reimbursable prepayment for services. The project finance option has two major drawbacks. First, it would require significant revision of the procurement regulations. Second, such an arrangement would require commerical infrastructure companies to first obtain major government user agreements before being able to proceed to build the infrastructure. These requirements would effectively eliminate this approach to financing as a practical solution.

The all-equity option is also possible, but as in the project finance option would be quite difficult to achieve. As you can imagine, those who put large sums into early commercial endeavors are special investors. They are accepting enormous risk and a very long-term investment horizon. These type investors are rare indeed. In order to attract such investors a company must first have a very sound business plan, must continually achieve specific milestones, and must demonstrate both technical and business adroitness. But as the program goes from the tens of millions needed to design and develop an infrastructure program to the hundreds of millions needed to construct major space infrastructure, the total capital requirements would quickly overwhelm the emerging space equity markets. The only way to attract construction scale equity is to clearly show that, if the program is a success, the return on equity is adequate to account for the huge risk. If one is forced to all equity finance, assuming it was even possible, the effect in order to provide adequate return, would almost certainly price the product being developed out of the market. Thus, for two reasons, an inadequate equity pool and the impact on product pricing, it makes the all-equity financing option poor at best, and most likely impossible.

Finally, the third option, risk sharing through a form of federal loan guarantee, we believe would be the most desirable means to encourage the development of the commercial space industry. Such an approach would provide clear and substantive risk sharing between the public and private sector, would provide an unintrusive means to assist efficient commercial programs, and would require substantial equity risk in order to qualify for the risk-sharing program. The result would be the rapid development and operation of substantial commerical infrastructure such as the ISF.

This approach, we believe, is also the preferred approach for the government because it is straightforward, requires significant private sector risk assumption and leads to pricing of services that will allow a truly commerical industry to develop. Furthermore, it is fair since the government is assuming risks that are essentially government-created and which cannot even be measured, much less borne, by the private sector.

Mr. Chairman, the Space Industries team is prepared, able, and eager to continue to move forward with the ISF program. We believe this program would be an excellent flag bearer for commerical space development, with substantial programmatic and long-term financial benefit to the Government and to industry. We are prepared to invest major capital and other assets in equity, but such private investment would have to be leveraged by guaranteed debt to be viable.

We realize that loan guarantees on the surface are not popular with the current administration. But clearly, unlike cases where loan guarantees have been used to support faltering industries, a potentially new and important industry for the United States is being helped. And industry in doing its part by risking substantial equity in an area of business that currently does not exist and which has risks for beyond those normally associated with alternative terrestrial investments. The capital requirements are enormous, but so is the ultimate potential of commercial space. Without an immediate and substantial risk-sharing program, we fear our program and those that might follow, will have a very difficult time.

We appreciate your careful consideration of this fundamental issue, and hope that quick action can be taken which could allow our nation to become the dominant world force in this new industry. That is a position to which Americans are entitled given our country's $200 billion dollar investment in space and traditional position of world leadership in the development of new technologies. Thank you for your time and attention.

Mr. Calaway and I will be happy to address your questions.

Senator **BENTSEN**. Well, there you show us the problem with the diversity that you are talking about. You have a diversity of commercial space interests here. Each one of you has a specific requirement if your activity is to be a commercial success.

Mr. Slayton, you are trying to contract for government payloads. Mr. Ferguson talks about consistent government policies, investment incentives and more payloads, and Mr. Scott talks about loan guarantees, reliable shuttle servicing with NASA support.

Other commercial companies have other things they are talking about. Is there one common denominator where we in the Congress can be of help, that doesn't hurt one, help the other?

Do you know something we can do that can be of assistance that is not favoring a particular sector over the other?

Is there a dominant theme or principle?

Mr. SLAYTON. Well, sir, I do not think so. I think you put your finger on the problem. There is a diversity, obviously, and from our point of view, even within our industry, there is a diversity because you will hear the large booster people say, we need a government subsidy to stay in business.

We are not proposing government subsidies. We think we can make a viable business on a commercial basis, and that is what we are trying to do.

We are searching for government business, but we are doing that on commercial terms. All we want is a fair shot at the market. We are not asking for any favoritism. So I think in that respect, we are a little bit different than some other people.

Mr. CALAWAY. Senator Bentsen, if I could make a comment on that.

Senator BENTSEN. Yes.

Mr. CALAWAY. As in all industries, to try to group all the different niches and say there ought to be some common problem, I am not sure that that is possible.

Senator BENTSEN. I am not sure it is either.

Mr. CALAWAY. In particular, an important distinction are those that want to be in the launch service business, which we have talked a lot about here, versus those that actually want to conduct commercial space-based services that require men in the loop, the manned factor versus the unmanned factor is very important here.

In particular, if you want to engage in manned oriented space-based activities, that linkage, that critical linkage with the government through the shuttle system creates the fundamental risk that we seek from the financial perspective.

In other words, if you have to depend upon the government transportation system for not only deployment but for ongoing services, the reliability of those services are essential to your risk profile.

If that cannot be addressed adequately, that risk element, then either the space-based services will not be financed or the government has to step in to help risk share with the private sector for that part.

Senator BENTSEN. Well, let me ask you another one here, talking about no subsidies. I always prefer that if we can find it, but I look at the competition of these other countries and what they are doing in the way of subsidies.

I listened to one of the witnesses earlier talking about the French, how they are moving up to 50 percent of civil space leadership.

What kind of subsidies are they getting? Do any of you have an idea—have you done any research as to what we are facing in the way of subsidies?.

Mr. SLAYTON. We have in the launch business, Senator, and I can tell you very clearly, if you want to talk about the Chinese and the Russians as typical examples, that the subsidies is in essence—"tell us what your price is and we will beat it." That is what we are really dealing with.

So any price you want to pick for a commercial launcher, if they choose to, they will undercut it by enough of a percentage to make it attractive.

On the other hand, I think the service that they can provide the customer is not on a par with what the U.S. launchers will give them.

Senator BENTSEN. That's what I want. Is the price differential, do we have any innate advantages that make up for that kind of a price differential?

Mr. SLAYTON. To a certain extent, we do, sir, but I do not know exactly how to quantitate that. That is the problem. There is no doubt that the U.S. companies, and probably many foreign ones, would choose to use a U.S. launcher versus a Russian or a Chinese one at some increased price but if they get it for half price, they have got to stop and think.

Senator BENTSEN. At some point, they have to look at price, do they not?

Mr. SLAYTON. Yes, sir.

Senator BENTSEN. Well, as a nation, can we afford not to compete in the commercialization of space? We would have some great losses we would incur, it seems to me, technologically.

Can we have some comments on that?

Mr. FERGUSON. Well, I think that is absolutely right. I would return to the analogy of the Olympic Games, but of course, these are not games.

This is a new area, much like the oceans, and we, as a nation, made great strides in developing some of the commercial opportunities of the oceans. Houston has done that.

I believe that if we are left at the starting gate here, there are going to be new technologies, new products, whole new ways of living from which the United States will be shut out.

Mr. CALAWAY. Senator Bentsen, a comment on that.

Senator BENTSEN. Yes.

Mr. CALAWAY. The Soviet Union, as I think you pointed out a number of times in hearings, is flying a manned space station as we speak.

The way that the current government policy and current programs read, they will continue to do that unchallenged for between eight and ten years, depending upon who you want to believe.

Space Industries, we are a commercial concern, we are involved in a major way in providing an option to allow us to not have to wait that long. We can be up there and begin to effectively challenge that position in the 1991-92 period.

It is much more limited, certainly, than the government space station, but from the point of view of power, time on orbit, research, and critical materials processing area, and in other areas, we do provide an option that is much earlier than the space station as a stepping stone to that very space station.

So I do not think we can afford to wait 10 years and let them have all of that operational experience for our space station, and we offer a commercial strategy to interim step to that space station.

Senator **Bentsen**. I have heard recurrent comments about a commercial launch facility. I know the State of Hawaii is actively pursuing that idea. I have listened to Senator Inouye bring that up from time to time.

Mr. Frankle testified earlier today that a mature, commercial, expendable launch vehicle industry cannot be dependent upon the marginal availability of government owned assets.

What familiarity do you have with that, and are there other likely sites that are under examination at this time?

Do you have any kind of a ballpark figure as to what such a private major launch facility, or if it was a government facility for commercial launch activity that was made available on a feed basis for industry?

Do you have any feel for what that would cost, any of you?

Mr. **Slayton**. Well, sir, we do on the small vehicle side. Again, I cannot speak for the large vehicles, but we have been looking at Hawaii for 5 years as a potential commercial site.

The only reason we backed off was because of the 1984 policy which encouraged us to move on at the government ranges, and at that point we started to negotiate with NASA and the Air Force to operate from the government ranges.

We still do not know for sure that we can afford either one them, because we have not got our costs nailed down completely yet. If it turns out that we can do a better commercial operation off the government range, we will certainly charge for Hawaii very rapidly.

We think today that the quotes we are getting on direct costs, which is what we are obligated to pay NASA for the use of Wallops, will be competitive with what we have been bookkeeping in our books.

If it turns out not to be the case, we would certainly move to another range. It is simple for us to do, though, because we have a small vehicle, solid propellant, and for the ballpark cost of $5 million we can set up a launch site almost anyplace in the world.

Now, you talk about a space port, if you will, such as the Senator from Hawaii is speaking of, that will adapt to big vehicles like Atlas, Titan, and Delta, for example, you are probably dealing with somewhere in the ballpark of a half to three-quarters of a billion dollars, and that is a massive investment.

Senator **Bentsen**. Do you see a totally private infrastructure approach feasible or realistic? I would assume you would say yes, from the small launching site.

Mr. **Slayton**. Yes, sir.

Senator **Bentsen**. But you start getting into a half billion, three-quarters of a billion, or whatever that figure is, is that feasible?

Mr. **Slayton**. No, sir, I do not believe it is.

Senator **Bentsen**. Without government participation.

Mr. **Slayton**. Right. I do not know what logic you would use to do it, if you were trying to show a commercial basis for doing it. Presuming that you have Vandenberg and Kennedy available to the large boosters today what logic would drive you to duplicate that infrastructure somewhere else, I do not know.

You would have to presume that either one or both of those places suddenly is not operational, and whatever logic caused you to reach that conclusion would probably tell you Hawaii is not available either.

So I do not really know how you would rationalize that.

Senator **Bentsen**. And you would have your foreign competitor that would move in on you with a government site, I suppose.

Mr. **Ferguson**. One important factor in site selection is proximity to the equator, and Arianespace was very clever in locating its primary launch area in French Guiana.

I think that the only reason I could see for putting together a new launch facility would be to try to locate closer to the equator where you get more of the Earth's energy to give you an initial boost, which translates to more payload on orbit, and second, to perhaps incorporate new technologies, lessons learned over the last 20 years of launching, to build cheaper, better facilities.

I agree with Mr. Slayton that as a commercial prospect it is a nonstarter. It really would require a very strong government partnership.

Senator **Bentsen**. I yield to my colleague, Senator Pressler, for any comments he has, or questions.

Senator **Pressler**. Mr. Ferguson and Mr. Slayton, as entrepreneurs you are keenly sensitized to the principles of free market enterprise, and as you are aware, the Soviet Union has begun marketing its Proton ELV in the United States and abroad. Yet these marketing efforts in the United States have been thwarted so far by the State Department's objections based on technology transfer concerns.

Should we welcome competition, regardless of its origin, as a matter of consistency with our nation's long-standing free market position, or because of the fragile condition of our domestic ELV industry and the unique nature of launch services, Should we prohibit the launch of U.S. satellite technology on Soviet ELV's?

I would like Mr. Ferguson's response to that question first. Mr. Slayton, who I know was a member of the Apollo crew that docked with the Soviet Soyuz spacecraft in 1975, might have some special insights on that question, as well.

Mr. **Ferguson**. Senator, my personal feeling is that we are in a terrible position to have to make such a decision. On the whole, I feel that if the Soviets are willing and able to launch commercial satellites at a low price and willing, presumably, to fund the launch of American satellites, they should be able to do so under our law and there should be no obstacles placed in the paths of commercial satellite companies who want to launch on them.

But I feel it is an entirely undesirable state of affairs that should be corrected as soon as possible so that U.S. satellites do not end up flying on foreign launch vehicles.

Mr. **Slayton**. Well, sir, I cannot speak to the sensitivity of the technology. I can only say we are worrying about a transfer of technology, and I cannot judge that one. Presuming that is an issue, you would have to be very naive to presume that you are going to take a satellite and get it transferred from the United States to the Russian launch site and off the pad without them knowing a little something about it.

They are proposing that you are going to have your own people on site and do whatever you want to do and there will be no disclosure of anything related to your payload.

I think during Apollo-Soyuz we were the only people from the West to ever be on their launch site, except Charles de Gaulle. As far as I know we still are the only ones from the United States. They flew us in there at night and flew us out at night just to make sure we did not see anything.

I cannot believe that they are going to let any western satellite get from its origin to the launch site without having a bit of intelligence related to it.

So if that is an issue, it will never work.

Senator **Prestsen**. Mr. Ferguson, your company was affected adversely when the administration decided in August of 1986 to remove nonshuttle unique commercial payloads from the shuttle.

To the best of your knowledge, to what extent have these payloads made other launch arrangements?

Mr. **Ferguson**. To the best of my knowledge, possibly two and as many as four commercial satellites have now signed anything like a firm launch reservation with other launch providers, such as Martin Marietta, the provider of the Titan, or General Dynamics, the provider of the Atlas Centaur.

Many of them, in fact most of them, I believe, have signed agreements very quickly with Arianespace which I now regard as the primary launch provider in the west.

There is a capacity problem that Arianespace has, just as we have known all along, but I believe that the record would show of those satellites pulled off the shuttle, most have gone overseas to Arianespace.

Senator **Pressler**. I might address this to all of you, but to Mr. Scott first. Give us some assessment of what the situation is like in terms of obtaining investment capital—what kind of a reaction you get when you go to investors.

Presumably one reason that Space Industries is seeking a loan guarantee is that there is insufficient investment capital available for projects such as the ISF.

Have you in fact found this to be the case, and to all of you who obviously have met with investors, what is your assessment of the investment capital market for commercial space ventures?

Has it been affected by the *Challenger* accident and its after-effects, and why, in your opinion, are investors reluctant, if at all, to invest in commercial space ventures?

I might start with you, Mr. Scott.

Mr. **Scott**. Senator, our situation has been that in the early development stage we have had no problem, really, in attracting investors, but we are talking about very small amounts in relation to what we eventually would have to have.

To finish our program, there is no question we will have to have major financial help. We think it can be done with loan guarantees and then turn to the private sector, but no question we will have to have some type of government guarantee to go forward with our endeavor.

Mr. CALAWAY. If I could just go from where Mr. Scott left off, we have raised significant money but at this point as commercial—from the point of view of total commercial commitment, if Senator Bentsen's estimate of $100 million is correct, we represent 25 percent of the total investment in commercial space at this point.

Unfortunately, in all major infrastructure programs, whether they be government or private, we have a pretty rapid ramp-up as you move from the engineering design phase to the manufacturing phase.

We are looking at a program that is several hundred million dollars worth of expense. We have attracted most of our capital from strategic alliances with large corporations at this point, and expect that that will be a major source of capital, equity capital for the future.

But we do not believe, given all the enormous risks that are faced, as well as the immature nature of the capital equity markets for space, that the hundreds of millions of equity will come forward without being shared by the government in some form, and particularly dealing with the debt component of the total capital.

We do not see government contracts being adequate to address the debt problem, and that is why we reluctantly come forward with the idea of some kind of loan guarantee program.

Mr. FERGUSON. I would only observe that investors want a return on their money, and in so many commercial space areas there is no reasonable prospect of a good return. There are all sorts of reasons for that state of affairs, but there it is.

Mr. SLAYTON. Well, again, we are a little bit unique in that we have two things going for us.

Number one, our capital requirements are not near as great as some of the other people's. We are not dealing in hundreds of millions, we are dealing in tens or less.

Secondly, being in the launch business, we obviously get paid before anybody else does. They have to pay us before they get up there, and that is one reason we like our business

In spite of that, however, we still discover that the venture capitalists are not highly venturesome and funding is a continual hassle but we are confident we are going to resolve it. As usual, the solution is customers, and when you have the customers, the money is there.

Senator PRESSLER. Mr. Chairman, I have no other questions but I would like to thank the witnesses for their candid and complete responses to our questions.

Senator BENTSEN. Yes, of course.

Thank you very much, Senator Pressler. Mr. Slayton, when you were discussing the use of Russian launchers for some U.S. payloads, and the question of the security of those payloads, I could not help but think of the U.S. Embassy in Moscow, which has been turned into a gigantic broadcasting transmitter for the KGB. So I think I would agree with you that there would not be much security in that.

Well, it has been a very interesting hearing. It seems to me that where we are, today compared with what we looked at ten years ago, 20 years ago, some of the estimates, and some of the forecasts about the incredible payoff in commercialization of space, well, the deal has been cooking for a while now and we have found out that it is not as easy as some thought and the transfers of technology take longer than we thought, and the applications in particular.

But it also seems to me, as I look at the competition around the world and where they are trying to move in other governments, that finally the time has arrived and that this nation in no way can afford not to be a part of that competition and a leader in that competition, because the payoffs in technology and prestige, balance of payments, all of those things are there and we must be a part of it.

I want to thank each of you, and all the witnesses we have had this morning. All those remarks that you have made will be evaluated and we will study your entire statements for further study and research.

I want to thank in particular some others that did not personally testify because of the time limitations. I thank Effort, Inc., and the Space Business Information Center for their testimony and I will include copies of their testimony in the hearing record.

What we have seen today is the first step for this subcommittee in trying to understand the barriers that we have to space commercialization, and we are going to continue to investigate those issues.

What we are looking for, obviously we cannot address all of the economics, but we do not want government standing in the way, and if we can find ways from a legislative standpoint where we can be of help, that is what we want to do.

As we go along on this, we would appreciate any additional inputs you might have and we appreciate your efforts today. I think that we have some great opportunities out there and I think the time is about ripe to try to implement them.

Thank you very much for your attendance.

[Whereupon, at 11:15 a.m., the subcommittee was adjourned.]

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

STATEMENT OF EUROPESPACE-USA INTERNATIONAL INC.

Senators Bentsen and Pressler: Europespace-USA International is one of the new Houston entrepreneurial ventures that you have heard about in these hearings. We are composed primarily of retired government and industry veterans of the U.S. Manned Spaceflight programs, and we are offering support to U.S. and European companies in the development of cooperative commercial programs, marketing of products and services, and the provisions of management consultant services by our growing world class network of experts and consultants.

"Commerce in Space" implies the existence of a marketplace, with buyers and sellors. At the present time, as you already knew and have heard repeated again today, the primary buyers, both in the U.S. and Europe are the governments themselves, represented by NASA, ESA, the Space agencies of the individual members of ESA and of other nations throughout the world. Companies involved in providing launch vehicles and services, and/or satellite and payload development and operations tend to be big businesses, and therefore have an inherent advantage over the emerging small companies such as Space Services and Orbital Sciences Corp. This is primarily due to their large business base with government agency contracts. This holds true in Europe as well as the U.S. The major U.S. aerospace companies have enjoyed a dominant market share of world aviation and space business for over 25 years. This situation is changing radically. Now other countries and their aerospace companies are beginning to compete effectively in this field, at least for their own government's business. Some Americans have made the charge that unfair government subsidies are the principal reason for the loss of U.S. market share. There are in fact subsidies, on both sides, they simply may not be as blantantly obvious in the U.S. system. Another reason that is given for loss of market share is the charge that other countries have been copying U.S. technology—the so called "Technology Transfer issue". There are serious defense problems inherent in the commercialization of some Aerospace technology, however, this doesn't seem to be a problem in military applications where NATO sponsorship can permit a European country to build and produce first line U.S. fighters under a U.S. license. We need a similar mechanism in the civil space world, that will enable us to be able to transfer first generation space technology, no longer of critical defense value, into commercial benefit. A case in point is the success of the French "Spot Satellite" which provides imaging from Space for commercial users. This was a technology pioneered by the United States with U.S. tax dollars, and which we were unable to commercialize properly.

In the case of our European Allies, we need to recognize that they have advanced aerospace technology equal to ours in many fields, although not as large in overall resources and scope. It's also important to understand the value of encouraging joint cooperative efforts with our closest allies to combine talents and resources on future major programs such as the Space Station and follow-on programs such as the Lunar Base and Mars expedition. Equal in importance to these government programs, is providing the legislative authority to encourage joint commercial teaming ventures of U.S. and European companies on U.S. and European programs. A plan should be negotiated with the EEC, to permit U.S. companies to compete as team members on European companies teaming on U.S. programs.

Also needed are international provisions for set asides and special help to emerging small business in the commercial space manufacturing field. The mortality will be 100% unless such help is provided.

The time of the export only oriented U.S. manufacturers is quickly disappearing. Future opportunities for U.S. and European companies will require multinational efforts to share resources, risks and opportunities and to maximize gains from compatible teaming. Such teaming in government and commercial ventures is highly desirable from numerous perspectives. It will enhance Atlantic Alliance cohesion, provide shared scientific objectives, achievements and data and ensure constructive cooperation instead of destructive competition in an emerging world marketplace.

It will provide psychological and social benefits to free world societies and prevent the high cost of missed opportunities in the driving technology of the age, helping to insure a solar system devoted to peaceful commerce and scientific exploration. The barriers to International cooperation as previously stated and suggested legislation solutions are as follows:

Technology Transfer Concerns: Simplify and change the U.S. Dept. of Commerce rules to permit 1st generation technology commercialization.

Bureaucratic Licensing Process: Provide, by legislation, for a multiagency commercilization licensing clearing house in one U.S. location for all civil space licensees. (Houston recommended).

Agency Competition for Resources and World Leadership: Moderate and encourage a NATO type approach with our Atlantic Alliance allies in Europe. Do this outside of ESA if necessary.

Market Sector Protectionism: Resist any efforts to legislate embargos, penalities or import taxes and other provisions which would favor efforts at domination of the market at the expense of International trade.

Inadequate Communication and Data Exchange: A Clearing House is needed for coordination of World Space commercial requirements. This should be established in Houston, Texas. The Commercial Space Capitol of the United States.

In conclusion, the talent and interest in commercializing space is resident in Houston, and we in the Eurospace—USA Int'l organization urge that the U.S. Congress recognize the importance of International trade opportunities in the Commerce in Space Act. U.S. leadership in Space as in any other sector must be provided first and foremost by our political leaders. We are grateful for your interest and the opportunity to present these views for your consideration.

STATEMENT OF NANCY WOOD, EXECUTIVE DIRECTOR, THE SPACE FOUNDATION

Senator Hollings, Senator Bentsen, Senator Pressler, it is timely and appropriate for your subcommittee to meet in Houston where there is such keen interest in harnessing the benefits of space. You are in the right city at the right time to address issues of economic competitiveness in the space business arena.

The Space Foundation is happy to see legislation proposed to encourage commercial space development. In addition to funding graduate research in space, the Space Foundation began the Space Business Roundtable in Houston in 1983 which currently has 300 members and meets monthly to provide business leaders with background briefings on the business frontier of space. Now we have six other chapters of Space Business Roundtable in Washington DC, New York City, central Florida, Dallas, Seattle and Los Angeles.

It is a national issue (not just a Houston priority) that the wisest fiscal policy the US could develop needs to have a solid foundation to link space and business. Many nations are poised to bring in the rich harvest from space. Our pioneering nation can be at the forefront only if we enforce the 1984 amendment to the NASA Space Act to *"seek and encourage to the maximum extent possible, the fullest commercial use of space."*

In many other nations patient money, long term thinking and aggressive market share strategies are bringing government/business/academic partnerships of awesome competitive threat. At present we still retain the most advanced space technology, but looking over our shoulder we see powerful competition advancing.

Space enterprise has potential for large markets on Earth, generous export sales and continuously generating revenues for the nation with access to space and an energized space industry. Medicines, pharmaceuticals, remote sensing, solar power, materials processing and cost effective space transport and orbital services will create new wealth for the nation which combines advanced technology and nurturant policy.

New wealth for space is not just of value to space buffs. A civilized people can't support services to elderly, health care, economic stewardship or the arts without an expanding economic pie.

The entreprenurial strength of the nation is a formidable tool for progress. Private enterprise can do amazing feats with a risk taking mentality that creates wealth out of opportunity. But national policy relating to space has been blurred and muffled the message to business. There is a real need to simplify and clarify US commercial space policy related to key issues such as access to space, insurance and pricing. Regulatory barriers and shifting government pronouncements are inconsistent with a strong competitive posture for US space business.

Multiyear funding should be provided for programs that require long term commitments. Space technology advancement funds should be assured at a significant level as should space science budgets. To do less is to shortchange the coming generations.

Strong commitment to an operational space station is essential. Soviet research time on an operational station is years ahead and there is no adequate substitute for on orbit microgravity research. We must not relinquish our leadership in space to be only participants or bystanders.

The Commercial Space Policy of NASA written in 1984 contains many initiatives to stimulate research and development, initiatives to reduce risk and initiatives to establish new links with the private sector. Only a few of these have ever been implemented by NASA. In preparing legislation for the Commerce in Space Act, the committee will find some excellent building blocks for strong legislation by a critical review of the Commercial Space Policy document.

The best way to unleash the nation's business strength to harvest the benefits of space is:

1. To form consistent policy
2. To support commercial endeavor as fervently as the Japanese
3. To fund NASA properly to assure constantly advancing technology
4. To remove barriers to private initiatives
5. To expedite a Space Station workshop

Thank you for your fine efforts on behalf of the nation.

STATEMENT OF
Owen K. Garriott
President, EFFORT, Inc.
October 5, 1987

The very necessity for hearings focused on sustaining commercial activity in space is evidence itself of the marginal viability of these new ventures. Without manifest positions and signed Agreements in place, it would be imprudent if not foolish to make major investments in space hardware which might never be flown. Certainly the Challenger disaster (Mission 51-L) has had a severe, but not necessarily fatal, impact on commercial ventures and similarly, on plans for the conduct of science and technological research in space.

In only the last few weeks, the NASA has apparently decided it must defer or deny leasing arrangements to Spacehab, Inc., it may consider renegotiation of several past Agreements and possibly cancel additional science missions, where they have not yet been fitted into the manifest. While encouragement of false hopes will only exaggerate later bitterness, in this case, it seems the NASA action is unnecessarily severe. Just as recovery from the Challenger problems begins to look a bit more optimistic and possible Shuttle improvements begin to look reasonable (described below) the worlds of science, technology and commercial space research may be forced "to get off the bus" altogether!

The Down-Weight Constraint

What are these improvements on the horizon? First, keep in mind that the present nominal end-of-mission down-weight maximum for Orbiter is 211,000 (211K) pounds. This is a severe constraint for all Spacelab missions, because the whole payload must be returned from orbit to a landing, unlike "deployment" missions, where satellites are sent off on their own, substantially reducing the Orbiter landing weight. Yet these Spacelab missions (and potentially Spacehab flights) are the ones with opportunities for scientific, technologic and commercial research. The down-weight constraint prevents utilization of the current launch capability of Shuttle-Orbiter. For every present Spacelab flight in the manifest, at a nominal altitude of 160 nm and inclination of 28 degrees, there is 20K to 24K lbs of excess launch capability (performance margin) that cannot be used because of the down-weight constraint (see Attachment A).

In order to increase the down-weight limit, NASA and contractors are completing a new thermal analysis of Orbiter heating on reentry (the so-called "6.0 loads analysis"). By early next year, a more complete understanding of temperatures and thermal gradients is expected to permit this limit to be increased from 211K to 214K lbs. But the major improvement which can follow will be to reduce the maximum g-limit when flying the Orbiter around the "heading alignment circle" just prior to landing. Reducing the limit from 2.5g to only 2.3g will permit an increase of about 16K lbs in down-weight to a total of 230K lbs at touchdown. This g-limit reduction seems quite reasonable and conservative, since 1.9g is the highest level ever experienced in 24 flights, and this when conducting a single, "controlability" test objective. Other than this one special test, 1.7g is the highest level ever reached.

This added down-weight capability can be a great boon to science, technology and commercial endeavors, whose principal needs are access to and operations time in space. (By "access to" is meant a position in the manifest and "operations time" can be provided by extending flight durations.) Following the Challenger accident, it has been necessary to drop over 60% of the planned Spacelab and other science missions, because at the new reduced flight rates, there was no room in the manifest. Most missions dropped were repeat flights of Astro, IML, SLS and Atlas*, although some series were cancelled or just have not been scheduled. Most commercial ventures are awaiting their first flights, and certainly need locker space and substantial mass and volume in the Orbiter payload bay.

If the down-weight is increased to even 220K lbs, it becomes possible to carry the cryogenic energy kit proposed by EFFORT, Inc., with no weight penalty to any of the Spacelab payloads. At a 230K lb down-weight limit, the available performance margin has still not been fully utilized, and a number of other alternative configurations should be examined. These include:
Spacelab (LM)** + Spacehab + Cryo Energy kit
Spacelab (LM) + ISF/DM + Cryo Energy kit
Spacelab (SM) + two pallets + Cryo Energy kit

* Astro is an astronomy mission; IML is the International Microgravity Lab; SLS is Spacelab Life Science; Atlas is a multidisciplanary research mission, studying our atmosphere, plasmas, solar-terrestrial relations, etc.

** LM = long module; Cryo Energy Kit = EFFORT'S proposed cryogenic energy kit; ISF/DM = Industrial Space Facility/Docking Module proposed by Space Industries, Inc; SM = short module, Spacelab.

All of these configurations become possible from a weight and performance standpoint, although a full compatibility assessment is also required. Another benefit of the added down-weight limit is to make the Orbiter Columbia, which is about 7,000 lbs heavier than her sister ships, capable of carrying the heavier Spacelabs, which can now only be manifested on Discovery or Atlantis (DOD, SLS, IML and Atlas). Perhaps the greatest benefit to commercial and science users will be an opportunity to utilize the existing, but unusable, performance margin available on many missions, especially Spacelabs. As much as a 50% increase in payload weight and well over 100% in flight duration is possible with no change in Orbiter performance. Only an increased down-weight limit and use of a cryogenic energy kit is required.

Spacelab Science

All of the Spacelab missions are flown for the purpose of conducting research in space. Their results are at least approximately proportional to the time spent on-orbit; indeed, it can be argued that the last half of a two week mission is likely to be more productive than the first week. For example:

(a) Although a few experiments may fail in mid-mission, experience has shown it far more likely that an experiment will not work when activated for the first time in space. After repairs or adjustments are made, then operations become more productive. On

Spacelab-2, the most important single element (the Instrument Pointing System, on which was mounted the major solar telescopes) was repaired only 24 hours before time to come home. An extended mission would have resulted in several times more high-resolution solar data.

(b) Crew efficiency improves as experience is gained in working in space. Motion sensitivity should be expected to somewhat impair crew efficiency in the first three or four days. Skylab performance data showed improved daily productivity for at least 3 weeks.

More time in space is still needed for science, technology and commercial activity as demonstrated by the severe reduction in planned Spacelab missions and the inability of commercial payloads to get into space. Since real limitations will exist on the frequency of Orbiter reflights, extended missions are the only way to regain the lost time-in-orbit.

There is a simple way to estimate approximately the "value added" to a nominal 7-day flight, by use of a cryogenic energy kit as proposed by EFFORT. Transportation costs plus additional charges for a reflight mission are sure to exceed $100 million. Although these reflights are desired and were planned before 51-L, they are now seldom scheduled due to manifesting limitations. A flight extension to 16 days will provide more than twice the productivity of a nominal mission, so that "value added" must exceed $100M. Indeed, more detailed studies by the Center for Space and Advanced Technology (CSAT) under NASA contract, and internal studies to the Office of Space Science and Applications have reached similar conclusions.

Possible Difficulties with Flight Extension

It is sometimes suggested that extending the flight duration will delay succeeding flights, thereby further antagonizing the "User" communiities. To examine this quantitatively, assume that every flight extension from 7 to 16 days delays the next scheduled mission by a full 9 days, that each Orbiter flys 3 times/year and that there are 3 extended flights per year. Of course, with 4 months between scheduled flights for each Orbiter, there may well be no extra delay at all, but we will use this rather pessimistic assumption of 9 days delay after each extended flight. For the year, there will be 27 days or about a month total schedule slip. With four month launch centers, one full flight equivalent (perhaps distributed over the Orbiter fleet) will be lost every 4 years. In return, 12 extended missions will have been flown, each with over twice the productivity of a nominal 7-day mission. The trade is obviously very favorable to extended missions.

There can also be objections raised concerning the diversion of attention at the Orbiter Processing Facility, right at the time when attention must be focused on preparing for the first reflight. Certainly, the first reflight deserves top priority, but we must not completely ignore all other objectives until the first, or second, reflight is accomplished. The Orbiter modifications to accept the cryogenic energy kit are relatively small. The schedule simply needs careful examination to see how the modest changes can be made without impacting reflight preparations. It is essential to begin these modifications to accept the energy kit as soon as possible, so that it will be available to the earliest Spacelab and commercial users who want it.

It may also be important to note what should not be expected of extending missions to about 16 days. Flight durations of two or three weeks are clearly no substitute for, or even in competition with, our nation's Space Station Program. Our country needs the opportunity to fly continuously for many months at a time for life science and microgravity research. Extended Orbiter flights will be invaluable in providing the necessary preparatory experience for Space Station, but should not be viewed as even an interim substitute.

Barrier to Commercialization and User Interests

From our perspective it seems that the largest barrier to commercial and science interests is strictly NASA policy. A decision to better support commercial and science users could be made, without misleading those who need access to and extended operations time in space. Encouraging progress is being made in preparing for the first reflight. Just as important to commercial and science users, the means may soon be at hand to increase the payload of currently manifested Spacelab flights by about 50% and the time-on-orbit by more than 100%. This could provide access and additional operations time in space for science and commercial users, without using an extra spot in the manifest.

Status of EFFORT, Inc. Proposal

A proposal was first submitted to NASA for the private development of an Extended Duration Orbiter (EDO) capability by EFFORT, Inc. in January, 1986, shortly before the 51-L accident. Discussions with senior representatives of Codes I, E and M and the Administrator's Office have been held on numerous occasions since that time and correspondence exchanged. However, NASA has still not decided officially that:

(a) an EDO capability is of substantial benefit to the Agency and should therefore be developed,
(b) a privatized development by EFFORT and aerospace partner(s) and contractor(s) will be permitted.

It should be noted that the opportunity for a substantial increase in the down-weight limit is a relatively new development. This makes the cryogenic energy kit much easier to manifest and consideration of alternative configurations benefiting commercial and scientific users a possibility for the first time.

Recommendations

1. NASA should commit itself now to achieving a down-weight capability of about 230K lbs within the next year and certainly before the time at which the first Spacelab payload configuration becomes fixed.
2. Alternative configurations, some of which were suggested above, should be examined to more fully exploit the current unused performance capability of Spacelab and similar non-deployment missions.
3. A complete manifest review should be undertaken soon, including the participation of NASA science, technology and commercial user representatives (Codes E, R, I) and non-NASA representatives of commercial and privatization organizations.

4. **NASA should respond favorably to EFFORT'S proposal to privatize the development of an Extended Duration Orbiter capability. This will allow most early development expenses to be borne privately with user costs deferred until near the time of flight. Storage and maintenance tasks can be performed privately and flight readiness can be reached at the earliest possible time.**

Owen K. Garriott

ATTACHMENT A

Spacelab Down-Weight and Performance Margins

The Table below provides estimated margins for performance (the extra "up" weight capability available) and down-weight, given several assumptions. Currently, the standard end-of-mission or nominal entry weight for all Orbiters is 211K lbs. A new thermal analysis is currently in progress (the "6.0 loads analysis") which will provide extra confidence in the temperatures and thermal gradients expected to be encountered on reentry. This study should be completed by February, 1988, and is expected to increase the permissible down weight to 214K lbs.

The next limiting factor is reported to be the maximum acceptable g-level reached by the Orbiter while flying around the heading alignment circle (HAC) after reentry. Currently, the maximum permitted level is 2.5g. The maximum level ever reached in flight is 1.9g, achieved during a special detailed test objective. Other than this DTO, 1.7g is the maximum encountered It now appears that NASA intends to reduce the operational limit to 2.3g, after completion of the 6.0 loads analysis and verification by contractors of the suitability of this revision. With the 2.3g limit, approximately 16K lbs of additional down-weight capability is available, providing the data shown below. The total vehicle down-weight capability is therefore assumed to be 230K lbs. The basic vehicle, performance margin and cargo weights are obtained from flight summaries of October and November, 1986.

Weight Margins
(230K lbs down-weight capability)

	Total vehicle down-weight, Nominal entry	Down-weight +Margin, lbs	Performance Margin (up, lbs)	Cargo Mass	Payload elements
Astro-1	214,759	15,241	16,986	23,064	IG+2P
DOD S/L	211,313	18,687	23,724	26,968	LM+1P
SLS-1	211,219	18,781	8,850	26,968	LM
IML-1	211,137	18,863	24,650	26,870	LM
ATLAS	210,612	19,388	24,464	25,445	IG+2P

NOTE: IG = igloo, P = pallet, LM = long module

NOTE: SLS-1 orbital inclination was raised to 57° to gain a few hours of additional flight time. At 28°, this mission should have a performance margin comparable to the others.

STATEMENT OF SPACE BUSINESS INFORMATION CENTER

Section I -- BACKGROUND

The major goal for the United States space program in the 1980's has been the commercialization of space. President Reagan has repeatedly stressed the importance of this goal. The President issued the National Space Policy on July 4, 1982 in which he directed that the U.S. government "expand United States private sector investment and involvement in civil space and space related activities." One of the principles of that same policy was that "the United States encourages domestic commercial exploitation of space capabilities, technology, and systems for national economic benefit."

The White House followed up the general policy with a specific directive on May 16, 1983 concerning the U.S. position on the use of commercial expendable launch vehicles. "The U.S. Government fully endorses and will facilitate the commercialization of U.S. Expendable Launch Vehicles." The President also issued a National Policy on the Commercial Use of Space one year later (July 20, 1984) designed to remove some of the economic and legal impediments to space commercialization as well as promote vigorous research and development in the area.

Not to be outdone, the Congress also amended the National Space Act of 1958 to include the commercialization of space as one of the specific objectives of the National Aeronautics and Space Administration.

> "The Congress declares that the general welfare of the United States requires that the National Aeronautics and Space Administration seek and encourage, to the maximum extent possible, the fullest commercial use of space." [42 US Code]

NASA itself accepted the direction from the President and the Congress and issued its own policy on the commercial development of space. That policy was implemented by the Office of Commercial Programs at NASA Headquarters. Other major offices within NASA also took responsibility for implementing the commercialization policy, most notably the Customer Utilization Office within NASA's Space Station program. In support of these policies, the Space Market Model Development Project, out of which grew the Space Business Information Center, was funded by the Space Station Customer Utilization Office and the Office of Commercial Programs on August 1, 1986. The Johnson Space Center was given the responsibility for managing and supporting the project for these offices.

Section II -- RESEARCH RESULTS

II-1 EXISTING INFORMATION

The early research results indicated that space business information exists in many broad categories, and the accessibility of the information varies with the category. The most accessible is information about current affairs--regarding government agencies and major aerospace companies. Nearly everyone in the industry has easy access to industry magazines and newsletters and possesses essentially the same public information about what happens on a weekly if not a daily basis.

Scientific, technical, and government contracting information represent a second category of information. These public-sector data exist in large quantities. They are not as accessible, however, because relatively few people have the special training and equipment to use the electronic systems for indexing and retrieving the data. Original documents are usually not available in the libraries so that they must be ordered, delaying their use.

Private sector information constitutes the third major category of information. Most items in this category are incomplete. Lists of industry organizations, for instance, are available, but their usefulness for many business purposes is questionable. The criterion for including firms in these lists is not always clear, and the information about each firm is not sufficiently detailed. Furthermore, most of these lists are distributed in printed form, making analysis or manipulation of the information difficult.

Analytical reports on the industry also exist. However, at several thousand dollars or more per copy, they are outside the financial reach of most firms. Finally, publicly available market statistics are non-existent, except about government contracting and satellite communications. The lack of specific Standard Industrial Classification (SIC) codes for space markets means private space expenditures and revenues are merged with larger categories of government aerospace and defense and civil aviation. As a result, data for market estimates and projections for private space business are virtually impossible to locate.

In sum, information availability to the space industry runs from well-reported events and individual statistics in the news media to a complete lack of comprehensive market data for many space applications (Table I) .

TABLE 1

Information Availability and Accessibility

	AVAILABILITY	ACCESSIBILITY
News media	Excellent	Excellent
Scientific & Technical Literature	Excellent	Good
Government contracts	Excellent	Good
Organizational Directories	Partial (broad > deep)	Good
Business Statistics	Partial (govt > private)	Good
Analytical Reports	Partial (expensive)	Fair

The reason for the disparity in information availability is the traditional structure of the space industry to date. The government has been, and still is the largest consumer of space products and services, and they focus on basic research and the development of advanced technology for the future. Therefore, it concentrates on the **performance** and the **benefits** of space systems rather than on the **revenues** that such benefits might bring or the **profits** that could be earned through the most productive application of a technology. As any business person knows, real benefit to a potential customer is no foundation for a business unless that customer is willing to pay for it.

The information that does exist has served the traditional aerospace industry that has evolved from government contracts. What is lacking is the kind of information available in a private-sector market where the business-to-business or business-to-customer relations prevail. There the information is less science and government-oriented and more commercial.

II.2 Identification of Information Requirements.

The second research objective was to measure whether the participants in the space industry needed more information to do their jobs effectively and, if so, what information they need.

The overwhelming conclusion from interviews with all members was that respondents felt the available information about the space industry was inadequate for full market development. The lack of business information was identified by almost all of the respondents as a major impediment to space commercialization.

The problem as reported had two parts. First, certain information simply does not exist. Standard business statistics about space markets were the clearest example. The second part of the problem was that, even if information were available, it was difficult to locate and obtain. Respondents indicated extreme frustration at endlessly pursuing leads for information only to come up empty-handed. The respondents' experience is supported by our research staff members, who, after six months of fruitless investigation into certain information for space commercialization, are only now discovering major new sources of information.

Respondents also indicated the types of information that were most critical for business purposes. Current affairs was not mentioned as one of the necessary items by most respondents. They felt fairly satisfied that each knew as much as anyone else about the latest news in the industry. Of course, they all asked for ways of knowing what was happening before it appeared in the press, but those avenues of information were beyond the scope of this study. If anything, respondents complained there was so much information reported they had difficulty reading and understanding all they received. The desire was expressed for some type of service which would alert them to the items relating to their interest and that puts that news into an approximate context.

The most critical need was reported to be directory information. Respondents who have worked in the industry for many years have an informal understanding of who is doing business in space. Inexperienced respondents, however, have not developed that knowledge, and are daunted by the task of acquiring it for themselves. The need for directory information is a curious outcome in the face of the number of large and well advertised directories available. It is clear, however, that existing directories do not meet the total need for organizational information.

Another identified area was the need for consistent and believable market statistics for business planning. Firms in the space industry must base their market estimates upon individual market research reports (which tend to disagree among themselves about the current size of the market) or determine their own estimates (which tend to lack credibility in the eyes of investors or bankers). Since government statistics do not distinguish space activity from aviation or defense, business planners have a difficult time forecasting market growth, particularly when they do not even have a reliable estimate of the size of the current market.

In conclusion, respondents reported that the day-to-day happenings in the aerospace government-contractor market were well reported and, if anything, reported in more detail than desired. The greatest need is for directories -- lists of firms participating in space business and their major business interest. Other respondents expressed a need of market statistics for planning and investment analysis.

Section III -- SPACE BUSINESS INFORMATION CENTER DESIGN OVERVIEW

III.I -- Design Objectives

The second major objective of the Space Market Model Development Project was to design an information system to address the needs uncovered by the research activity. Specifically those needs are:

1. Easy access to information that does exist
2. Business information that currently does not exist for the space industry

To meet these needs, a prototype information system design has been developed. That design is embodied in the Space Business Information Center. The Center is a research organization devoted to providing information for space commercialization. The Center will continue to pursue the research objectives of the Space Market Model Development Project:

1. To catalog and evaluate the information currently available for the space industry
2. To investigate the unmet informational needs of individuals and firms in the industry.

The Center has also assumed a new set of operational objectives:

1. To develop new types of information that do not yet exist

2. To provide better access to existing information about space business to the business community.

The Space Business Information Center library contains major books, reports, and directories concerning primary market segments. The databases also contain information such as lists of shuttle payloads, satellite launches, launch vehicles, and firms involved in each of the markets.

The Center is currently pursuing four major strategies for disseminating space business information:

1. Publish factual guides and directories on various aspects of space business. The first guides will describe the market areas chosen as prototype areas in Phase I:

   Small accommodation Shuttle payloads
   Remote sensing of land areas
   Launch vehicles

2. Maintain an information clearinghouse whereby clients can request and receive specific factual information or documents about space business via telephone, electronic mail, post office, or delivery service.

3. Conduct research projects which involve primary data collection or analysis for specific clients.

4. Sponsor briefings on the various business aspects of space.

The guidebooks are under development and the information clearinghouse is in operation. The Center has also been responding to requests for primary data collection or seminars on space business as clients come forward. The Center's long-term objective is self-sufficiency as an information resource for the space industry--pursuing both public and private contracts for information about business in space.

Section IV -- New initiatives

One purpose of these hearings is to solicit ideas from the public on new initiatives in support of the commercial development of space. While the purpose of the Space Market Model Development Project was primarily to study the information available for space business rather than to make legislative recommendations, some of the conclusions of the study easily lend themselves to potential initiatives which someone interested in promoting space business could investigate. These suggestions, however, are distinct from the body of the research results. The research staff did not investigate these proposed initiatives and, as a result, has little to say on how they are to be implemented, what obstacles currently exist to their implementation, and what all the implications to their implementation might. One implication that be can clearly stated, nevertheless, is that to the extent these initiatives are successful, obtaining information about space business will be easier and more productive in the future. That in turn should support the continued development of space as a place to do business.

IV.1 -- Historical and operational statistics

The government's role in providing information to the public is currently under discussion in Washington. The Office of Management and Budget and various branches of the executive (Commerce, SEC, Agriculture) are reviewing what information the government provides and how it disseminates that information in anticipation of potential policy changes. These suggestions, therefore, are contingent on the resolution of these policy discussions.

NASA has traditionally been a leader in providing information to the public about the space program. Their working relation with the news media, particularly in broadcasting launches and space operations, is well known. NASA was also instrumental in establishing the on-line service industry in this country by contracting with the Lockheed corporation in the early 1960's for the research and development which led to the creation of NASA/RECON, the first searchable database of scientific and technical literature. Finally, NASA has expended great time and effort in disseminating the results of its research program through its networks of Industrial Application Centers. Thus, in most aspects, NASA is a model of public information dissemination.

One area emerged in this research project, however, which may require more attention--tabular data related to the history and the future of the space program. Tabular data, as distinct from text, is "structured" information about a particular activity. Examples of tabular information in the space program include launch histories, satellite characteristics, payload parameters, and budgetary information. While all of this information is obtainable in one form or another, none of it lends itself to business analysis. The problem is that various sources of the information will disagree (since there is no single authoritative source) and that the data is not disseminated in easily retrievable electronic form.

The problem was demonstrated acutely in this research program in our attempt to collect background information on small accommodation Shuttle payloads (middeck, GAS, hitchhiker, etc.). These experiments are a national resource and the presumed foundation of further investigation and commercialization of materials processing in space. On the other hand, it was extremely difficult to obtain information about these payloads beyond the simple listing of their name and mission. While NASA undoubtedly has this information, it is stored in databases which are not accessible to the public, or it resides in the experience of the individuals who worked on these projects. In either case, the data is not readily available to a business person investigating the possibility of doing microgravity research in space.

The suggestion, therefore, is that NASA investigate the expansion of its information dissemination program to include tabular data and statistics on the history, the operating parameters, the results, and the plans for the U.S. space program. These statistics, made available to the public in easily used print and electronic form, will help the business community better understand and appreciate the unique characteristics of doing business in space. The statistics will, in their turn, be included more often in standard business planning thus decreasing the risk due to ignorance and increasing business' likelihood to invest in space ventures.

IV.2 Market statistics

The Space Market Model research revealed another need for business information about space which the Federal government could address. Most economic and market statistics on the U.S. economy originate with the work of the Bureau of Economic Analysis (BEA) in the Department of Commerce. The BEA uses the Standard Industrial Classification (SIC) codes to segment the economy for greater understanding and more precise analysis.

Two SIC codes include most of the economic activity in space business. The satellite communications market is captured in SIC 48 (Communications). The other three-digit SIC code for space commerce is 376 (Guided Missiles, Space Vehicles, and Parts) which is part of the Transportation classification. Unfortunately, this second category is useless for analyzing the **private** space industry because it also includes all of the government activity in space--NASA activities, Defense space programs, and even DOD tactical and strategic missile programs.

The lack of a separate category for private space activity is understandable given the relative immaturity of the market. The lack of such information is an impediment to business nevertheless because an adequate understanding of the size and characteristics of a market is a pre-requisite to investment in that market. Business will not invest in space until it understands the current and potential revenues to be gained there.

The suggestion, therefore, is that the Department of Commerce investigate ways to measure the amount of economic activity in the private-sector portion of the space industry. Defining that sector would undoubtedly be fraught with tremendous difficulty. What is more, changing SIC classifications is no small matter since it would affect data series which are already useful. Without full knowledge, however, it is obvious that the SIC classifications have changed as new technologies and markets become part of the U.S. economy. By the same token, if space business succeeds, it will force its way into the classifications one way or the other. It would seem to be prudent to make plans now for that change so that it can be made in a timely fashion with as little disruption to the existing classification scheme.

IV.3 Business research

A final initiative would be an extension of the government's role of providing primary data as outlined above. Business people interviewed in this research project related their suspicion that doing business in space was different than doing it on the surface. They pointed to the longer lead times, the larger investments required, and the critical importance of government activity in this market as some of the important differences. What the business people did not have was a way of including these factors into their business planning.

The lack of these statistics is understandable because space is such a new area of business development. Nevertheless, it still provide an impediment because business people are not confident that they understand the space environment nor how to plan ventures there.

The suggestion, therefore, is that the Federal Government conduct or support studies into the economic aspects of space commercialization. The studies would be conducted using standard business statistics along with an analysis of selected cases--both successful and not successful. The outcome would be some benchmark figures on lead time, technology requirements, financing, and market potential. These figures could then be used for more secure development and investment decisions in this risky area.

Section V --

The Space Business Information Center at the University of Houston-Clear Lake has welcomed the opportunity to submit this testimony in support of the Senate Commerce Science and Transportation Committee. The Center is similarly prepared to submit any additional material which it can in response to queries or suggestions from the Committee.

The area of the Center's research interests--business information about the space industry--is not the only nor the most important impediment to the U.S. commercialization of space. It is a significant factor, nevertheless, since the private sector will not, and indeed should not, invest in ventures for which their estimate of return is not sufficiently clear to proceed. The lack of comprehensive, authoritative sources for such information, therefore, may be served to stifle some business interest in space commercialization.

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